July 29, 1952 K. O. F. JACOBSEN 2,605,090

UNDERWATER MINING DEVICE

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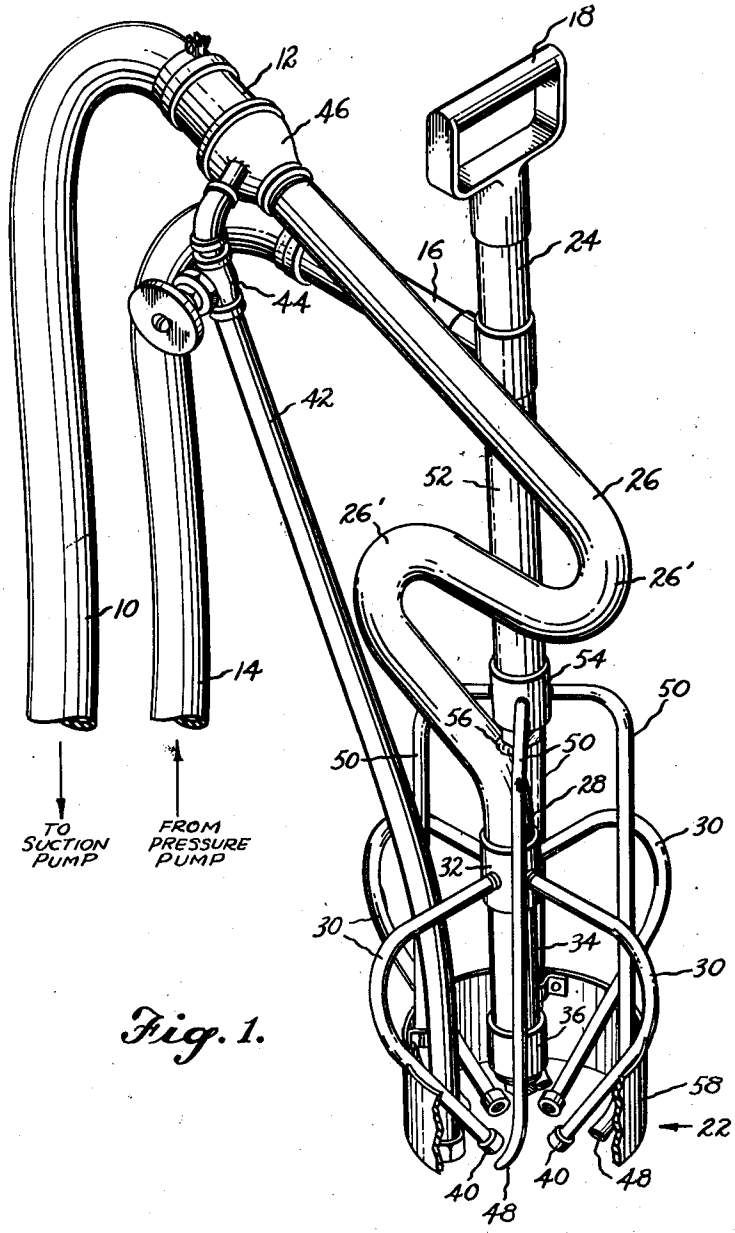

Fig. 1.

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Fig. 2.

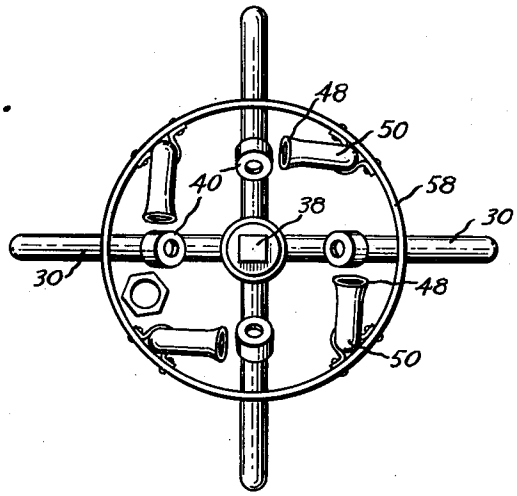
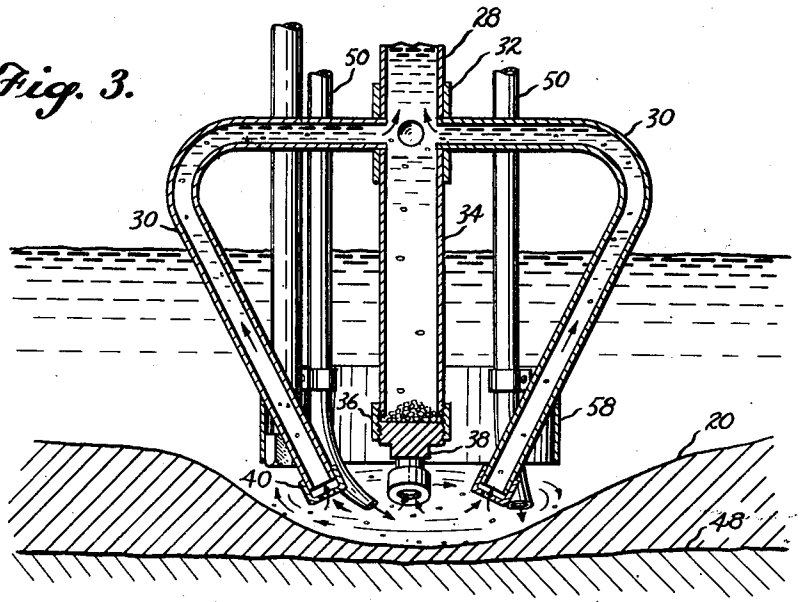


Fig. 3.



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UNDERWATER MINING DEVICE

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11 Claims. (Cl. 262—2)

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This invention relates to a device and method for mining of underwater placer gold and other heavy precious metals, and is herein illustratively described by reference to its preferred application, namely as a portable one-man operated means of taking gold and platinum, for instance, from creek bottoms or the shallows of other bodies of water, under which the alluvial material is largely of a more or less finely divided nature, including fine gravel, sand or silt.

Much of the world's remaining gold resources is to be found in places such as those mentioned above where either because of inaccessibility or the nature of the deposits, it is considered impracticable or uneconomical by previous means to undertake mining operations with mechanized equipment. Some of these deposits are rich enough that they are being worked at the present day by the laborious panning process. This technique, despite its limitations, offers the advantage over prior mechanized apparatus in that frequent moves may be made at little trouble and expense. Much of the gold in a deposit, especially that lying underwater or directly on bedrock cannot be recovered by panning, however.

An important object of my present invention is to enable mining of such placers by an inexpensive mechanized system which greatly increases the volume of deposit which may be handled in a given time, reduces the physical labor involved and can readily be accomplished by apparatus sufficiently compact and light in weight to be packed to any workable area by one mule, for example.

Another object is to make it more conveniently possible for the miner to reach and process underwater deposits, and especially to enable recovery of gold lying directly on bedrock whereas previously there was virtually no feasible way for accomplishing such a result by portable apparatus. Even in the case of heavier types of equipment such as the dredge, where useable, unless the layer of bedrock was quite thin and the entire layer could be taken and the gold separated economically therefrom, there was extreme difficulty in recovering such gold deposits. Since a stream bed has the characteristics of a sluice box, the bottoms of many rivers and creeks are known to hold considerable amounts of gold beneath the loose materials.

In attaining the foregoing and other objects, the present invention utilizes the principle of hydraulic suction by which silt, sand and fine gravel containing nuggets and flakes of gold are drawn from the bottom through apparatus which

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separates the heavier nuggets from the flakes and other materials and delivers the latter to a suitable disposal point for working and recovery of the gold flakes according to a selected process such as sluicing. In order to draw the loose materials into the suction inlet of the apparatus at a more or less steady rate, the heavier gold particles along with the lighter materials, the bottom in the vicinity of the suction inlets is agitated by jet streams of water directed in fixed relation to the inlets.

Preferably the apparatus comprises a plurality of suction inlets directed downward and inward at an incline in relation to, and toward, a common axis, and a plurality of agitator jets directed alongside the inlets and somewhat tangentially to create a swirling cloud of water and bottom materials from which the material is drawn into the apparatus more effectively than if there were no agitation provided. The streams from the suction branches merge above a trap into which drop most of the heavier gold particles or nuggets. Provision is made for convenient adjustment of the flow at the suction inlets so that when an area of a bedrock bottom has been swept of most of its light weight loose material the amount of suction may be increased in order to recover gold particles lying directly on the bedrock and more difficult to raise.

These and other features, objects and advantages of the invention including certain details of construction of its preferred and herein illustrated form will now be described more fully by reference to the accompanying drawings.

Figure 1 is an isometric view of the portable nozzle unit which the operator carries and applies to the stream bed to pick up the loose materials.

Figure 2 is a bottom view of the nozzle unit.

Figure 3 is a vertical sectional view of the lower or nozzle end portion of the nozzle unit shown in operation, the view being taken on a plane containing the axis of the lower end portion of the main suction pipe in the unit.

The drawings do not show all of the apparatus used in conjunction with the nozzle unit, i. e., the suction pump and the pressure pump coupled by hose to the suction and jet nozzle pipes, respectively, of the nozzle unit, and the auxiliary apparatus into which the suction pump's discharge is delivered for separation of gold particles from the other materials, these being components which can be of conventional form if desired.

In Figure 1, the broken-off section of hose 10 fastened to the short length of pipe 12 at the

upper end of the nozzle unit, will extend to the intake side of a suction pump, while the broken-off section of hose 14 fastened to the length of pipe 16, also at the upper end of the nozzle unit, will extend to the delivery side of the pressure pump. These hoses are of a sufficient length to permit the nozzle unit, held by handle 18, to be carried about by the operator for coverage of a sizable stream bed area around the temporary pump installation. The pumps may be driven by a small gasoline engine or other power unit which, together with the other apparatus, does not impair the portability of the complete set of equipment. In a typical case, the nozzle unit will weigh in the vicinity of 25 pounds whereas the pump units and gasoline engine may be selected to weigh less than 50 pounds for portable operations.

Standing in or over shallow water the operator applies the lower or nozzle end of the unit to the stream bed 20 as shown in Figure 3 while holding the elongated unit generally upright by its handle 18. In most instances the overall length of the unit between its nozzle end 22 and its handle 18 should be about 3½ feet for maximum comfort and convenience to the operator. When the nozzle unit is used to a depth in excess of about two feet, however, it is preferred to replace the handle extension 24 with a longer one, the operator's working kit preferably including extensions of various lengths for this purpose.

The nozzle unit has a main suction pipe 26 which extends from its somewhat larger suction outlet pipe 12 downward along a sinuous or other predominantly inclined path to a generally straight lower end portion 28 which is disposed substantially vertical in the vertical operative position of the unit, and is located generally at the unit's vertical axis. Suction branch pipes 30 extend radially outward from the union fitting 32 threaded onto the lower end of the main suction pipe 26. Preferably these branch pipes intersect the main pipe's lower end portion 28 or union 32 generally at right angles as shown in Figure 3, although some incline would not be objectionable. Preferably the nozzle unit incorporates a plurality of these branch pipes 30 arranged symmetrically in equiangular relationship about the axis of union 32 as shown in Figure 2, there being four such branch pipes in the illustrated case. These branch pipes are of considerably smaller internal size than the main suction pipe 26 which in turn is somewhat smaller than the internal size of the suction outlet pipe 12 and the connected suction hose 10 leading to the pump. In terms of standard pipe sizes the pipe 12 may be a 1½ inch pipe, the pipe 26 a 1 inch pipe and the branch suction pipes 30, ¼ inch pipes in a practical case. By employing branch suction pipes of that order of magnitude, the larger gold nuggets are more readily lifted in them by the suction stream because there is no great amount of room for the upwardly moving water to by-pass around the nuggets. As a result, therefore, these nuggets are carried upward by the full force of the stream in each branch pipe.

For the reason that the gold particles can best be drawn up by suction through a pipe if the pipe is inclined and its lower wall thereby affords some support to the particles, the main suction pipe 26 is given a predominantly inclined or sinuous form in which there are no long, directly vertical paths to be traveled by the upwardly moving particles therein. The short vertical bends 26' are not objectionable in this regard because the inertia of the particles is sufficient to enable them to be carried up these short vertical ascents between successive inclined sections of the pipe. Because of similar considerations, the suction branches 30 extend horizontally outward from the union 32 and then are turned downward and inward at an incline generally toward the central vertical axis of the nozzle unit. Gold nuggets traversing the horizontal sections of the branches entering the interior of the main suction pipe's lower portion attain their greatest velocity, hence are not likely to drop back out of the suction branch pipes once they reach the horizontal sections. The lower ends of these suction branches are spaced apart by an appreciable distance but preferably are directed toward a common point of intersection appreciably below the unit as shown. Loose particles drawn into these suction branches through their open lower ends travel upwardly along inclined paths and then horizontally into the interior of the union 32 which effectively constitutes a short extension of the vertical lower end portion 28 of the main suction pipe. As shown in Figure 3 the suction streams from the branch pipes 30 merge to form an upwardly flowing column of water and water-borne materials in the main suction pipe 26.

The nozzle unit has a nugget trap consisting preferably of a short length of pipe 34 threaded into the lower end of the union fitting 32 to form a downward continuation of the lower end portion 28 of the main suction pipe. This trap pipe 34 terminates at a location somewhat above the lower ends of the branch pipes 30 and carries a short union 36 into which a removable plug 38 is threaded to close off its lower end. Some of the gold particles which enter the interior of the vertical suction pipe section 28 continue to be carried with the upwardly moving suction stream because of a configuration which renders them comparatively light for their amount of surface area. Gold flakes are of such a configuration and will be drawn out through the main suction pipe 26 and the suction hose 10 with the lighter materials picked up by the nozzle unit. However, gold nuggets are generally somewhat round, hence comparatively heavy for their amount of surface area so as to be carried upward less easily than the flakes by the suction stream. Therefore, upon entering the interior of the vertical pipe section 28 where the branch streams merge, these nuggets will drop into the bottom of the trap pipe 34 and accumulate.

This separation process resulting in accumulation of gold nuggets in the trap below the intersection of the suction branches 30 is aided by turbulence of the merging branch streams and by the fact that the lower end portion 28 of the main suction pipe 26 is substantially vertical and affords no inclined or horizontal surface upon which the gold particles may rest in aid of being swept upward by the moving suction stream. However, the length of the vertical section 28 should not be excessive, since even the gold flakes normally require some amount of support to insure they will be carried upward with the suction stream of a velocity attainable by a pump of the size contemplated for portable usage.

In order to avoid the possibility of larger pieces of gravel becoming lodged in the suction branch pipes 30 and blocking flow therein, the lower ends of these branches are fitted with caps 40 apertured to a size of opening somewhat smaller than the interior cross section of the suction branches so that only those pebbles which will pass freely

through the suction branches are admitted into them. The size of these apertures is large enough, however, to pass any gold nuggets which will be found in the great majority of placer deposits.

As a further feature of the suction piping of the nozzle unit, there is provided the by-pass suction pipe **42** of ½ inch size in the illustrative case, having a flow control valve **44** and entering the union fitting **46** interconnecting the suction outlet pipe **12** and the smaller main suction pipe **26**. The lower end of this by-pass pipe, provided with a cap having a restriction aperture to block entrance of too large pebbles, is open and is located in the vicinity of the suction inlets **30** although appreciably above the same so that it will draw a larger preponderance of water than do the suction inlets. When the nozzle unit is first being applied to a bottom deposit of finely divided loose materials, the valve **44** will normally be open and the flow through the main suction pipe **26**, hence through the suction branches **30**, will be reduced by an amount corresponding to the flow through the by-pass pipe **42**. However, when a greater amount of suction is needed, as when the bulk of the loose materials is removed from the bedrock **48** (Figure 3), except for gold particles which lie directly on the bedrock which in many years past has functioned as the riffled bottom of a sluice box to collect the gold, greater suction is obtained at the inlets **40** by closing the valve **44** so that all of the flow through the suction hose **10** must pass through the suction branches **30** and the main suction pipe **26**. This it does at higher velocity and therefore with greater effectiveness, as later explained, to draw the heavier gold particles into the suction inlets. Another reason for reducing the suction when first applying the unit to a deposit of loose materials is that the suction pump will operate more satisfactorily if the percentage of solid material being drawn is not excessive.

Suction alone as a means of picking up loose gold particles and other materials intermingled therewith from the bottom of a body of water is in itself an idea which has been tried in various forms heretofore. Certain improvement features of the present invention relate to the provision of a portable nozzle unit having a plurality of comparatively small suction inlet branches, the discharge streams of which merge in a larger main suction pipe, both the branches and the main suction pipe preferably having inclined or horizontal surfaces to support the moving gold particles, the by-pass, the trap below the juncture of the branches and the main suction pipe, and the other features of the suction components of the nozzle unit, illustrated and described, separately and in combination.

A very important additional feature of the invention renders the nozzle unit far more effective in picking up gold particles and surrounding materials, however, than could possibly be obtained merely by the use of suction. It is true that a suction orifice placed close to and directed generally along the surface of a deposit of loose materials will draw these materials in some quantity into the orifice because by the sweeping action of the suction stream entering the orifice. The tendency, however, is for the lighter particles to be drawn off and the heavier particles to settle still lower by this process. Consequently gold particles are not all recovered by such a technique as effectively as desired. Moreover, if such a suction orifice is directed perpendicularly to the surface of the deposit something of the same result is obtained but with possibly somewhat lesser effectiveness. According to the invention the bottom deposit is first or continuously agitated by jet streams discharging in the vicinity of the suction inlets to set the loose particles into motion, suspended in water, so that the gold particles as well as the other materials can be drawn readily into the suction inlets. The jets raise the gold particles off their bed and the resulting motion of the water tends to suspend them long enough to be drawn into the suction inlets.

In the preferred and illustrated case, the nozzle unit has a plurality of agitator or force jets **48** corresponding in number to the suction inlets **40**. Each such jet orifice directs its stream at an incline downward, somewhat inward, and in a tangential direction along the outer and lower edge of a corresponding suction inlet **40** (Figure 2). Since these jets are directed generally downward the effect is to stir the bottom vigorously and raise the loose materials. Because of the tangential directional component of the jets, their combined effect is to create a swirling cloud of water and raised bottom materials in the vicinity of the suction inlets. Borne by the swirling water, the loose materials are readily drawn into the suction inlets **40**.

The action is illustrated diagrammatically in Figure 3, showing the manner in which the nozzle unit eats its way through the loose materials to bedrock. A bottom area will usually be worked in this way until the bedrock is largely swept clean of most of its loose deposit. Thereafter the same area will be swept again for loose gold particles lying directly upon the bedrock with the nozzle unit operating at higher suction by closing off the valve **44** in the by-pass pipe **42**. It is considered that a greater amount of suction is needed for this final sweeping or cleanup operation of a bedrock area than is needed during the initial stages, because the jet streams are more effective to raise and swirl gold particles embedded in other and lighter loose materials than they are when the gold particles are lying directly on a solid bottom; in the latter case a greater amount of suction is desirable for drawing the particles into the suction inlets.

The agitator jets **48** are formed by the lower ends of the pressure delivery branch pipes **50**, preferably pinched somewhat as shown to create a fan-shaped jet stream. These pipes branch from the lower end of the main pressure pipe **52** connected to the inlet pipe **16**. A union **54** is bored to receive the upper ends of the branch pipes **50** and fits over the lower end of the main pressure pipe **2**. The lower end of the union is plugged and is tackwelded to the suction pipe **26** at **56** as shown to rigidify the piping structure as a whole.

A circular shield and nozzle support **58** surrounds the lower or nozzle end **22** of the unit and serves as a mounting by which the suction pipe branches **30** and the pressure pipe branches **50** are supported in their desired relationship and shielded, so that despite considerable abuse they will not be bent or twisted out of shape.

The best manner of using the novel apparatus will depend to a degree upon the nature of the particular deposit being worked and is something which will be quickly learned by experience.

I claim as my invention:

1. In underwater placer mining apparatus a nozzle unit comprising a generally axially ex-

tending suction conduit having a lower end portion disposed generally upright in the nozzle unit's operative position, a plurality of suction branch conduits of substantially smaller size branching outward from said lower end portion and turned downward and generally inward at an incline to the vertical, said branch conduits terminating in lower end portions forming suction inlets for drawing of loose bottom materials into said branch conduits, pressure conduit means including a plurality of downwardly extending pressure branch conduits terminating in lower end portions forming similarly directed force jets directed generally downwardly and appreciably inwardly and tangentially about the nozzle unit's axis to create a vortex swirl of loose bottom materials in the vicinity of said suction inlets to be drawn into said suction inlets.

2. In underwater placer mining apparatus, the nozzle unit defined in claim 1 further comprising a by-pass conduit connected at its upper end to the suction conduit above the latter's lower end portion and extending downwardly therefrom the vicinity of but appreciably above the suction inlets, to draw water through said by-pass conduit and thereby reduce the suction flow through the suction conduit, and adjustable flow control valve means to vary the suction flow in said by-pass conduit relative to that in said suction conduit.

3. The underwater placer mining nozzle unit comprising a suction conduit having a lower end portion disposed generally upright in the unit's operative position, said suction conduit extending upwardly from said lower end portion along a predominately inclined path to its upper end portion, a plurality of suction branch conduits of substantially smaller size radiating outward at selected distance from said lower end portion and then turned downward at an incline to the vertical, said branch conduits terminating in lower end portions forming suction inlets, and a nugget trap mounted in position beneath said suction conduit lower end portion to receive nuggets dropped from the suction stream where the branch streams merge.

4. The unit defined in claim 3, and suction inlet orifice means having an inlet opening therein slightly smaller than the interior cross section of the suction branch conduits for excluding larger pebbles which might lodge therein and block flow.

5. The underwater placer mining nozzle unit defined in claim 3, additionally comprising a plurality of downwardly directed pressure jets located in the vicinity of said suction inlets and directed generally downwardly, appreciably inwardly and in corresponding generally tangential directions to create a vortex swirl of water-borne bottom materials around said suction inlet for influx thereof into said suction inlets.

6. The underwater placer mining nozzle unit defined in claim 3, additionally comprising a plurality of downwardly directed pressure jets located in the vicinity of said suction inlets and operable to create a swirl of water-borne bottom materials around said suction inlets for influx thereof into said suction inlets.

7. The underwater placer mining nozzle unit comprising a main suction conduit having a lower end portion disposed generally upright in the unit's operative position and having an upper end portion adapted for connection to a source of suction, a plurality of suction branch conduits of substantially smaller size than said main suction conduit and radiating outwardly from the vicinity of said lower end portion thereof and then turned downwardly and inwardly at an incline to the general axis of such lower end portion to form suction inlets grouped generally uniformly about such axis, and suction inlet orifice means on the ends of the respective suction inlets restricting the inlet openings thereof to a size slightly smaller than the interior cross section of said suction branch conduits for excluding larger pebbles which might lodge therein and block flow while admitting substantially all materials of a size capable of ready passage through said suction branch conduits.

8. The underwater placer mining nozzle unit defined in claim 7, and a plurality of downwardly directed pressure jets grouped about said general axis in the vicinity of the suction inlets and directed generally inwardly and tangentially in the same sense about such axis to create a vortex swirl of water-borne bottom materials for influx thereof into the suction inlets.

9. Underwater placer mining apparatus comprising a nozzle unit disposed generally upright in the operative position thereof and having a plurality of pressure jets, means supporting said pressure jets grouped about the general upright axis of the nozzle unit and directed generally downward and appreciably tangentially in the same sense about such axis to create a vortex swirl of loose bottom materials when positioned operatively at the bottom of a body of water, and suction conduit means having at least one suction inlet within such vortex swirl created by said pressure jets and drawing water-borne bottom materials thereinto for conveyance to a separating point.

10. Underwater placer mining apparatus comprising a suction conduit, a pressure conduit extending generally alongside said suction conduit, both being disposed generally upright in the operative position of such apparatus, a plurality of suction branch conduits radiating generally outwardly from said suction conduit and then curving generally downwardly and inwardly at an acute angle relative thereto to form suction inlets grouped about the axis of said suction conduit, and a plurality of pressure branch conduits radiating generally outwardly from said pressure conduit and then curving downwardly in the spaces between said suction branch conduits to form pressure jets in the vicinity of said suction inlets, said pressure jets being directed generally tangentially in a similar sense about said axis and appreciably inward relative to the general axis of said pressure conduit to create a vortex swirl of loose bottom materials to be drawn off by suction through said suction inlets.

11. Underwater placer mining apparatus comprising a suction conduit, a pressure conduit extending generally alongside said suction conduit, both being disposed generally upright in the operative position of such apparatus, a plurality of suction branch conduits radiating generally outwardly from said suction conduit and then curving generally downwardly and inwardly at an acute angle relative thereto to form suction inlets grouped about the axis of said suction conduit, a plurality of pressure branch conduits radiating generally outwardly from said pressure conduits and then curving downwardly in the spaces between said suction branch conduits to form pressure jets in the vicinity of said suction inlets, said pressure jets being di-

rected generally tangentially in a similar sense about said axis and appreciably inward relative to the general axis of said pressure conduit to create a vortex swirl of loose bottom materials to be drawn off by suction through such suction inlets, and a ring-like tubular member generally surrounding said suction inlets and pressure jets slightly above the lower ends thereof.

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