A method of completing a subterranean well having a well casing extending through an earth formation is provided, including the steps of: suspending an apparatus at a selected depth within the well casing; creating an unbalanced condition within the well casing; forming a lateral bore in the formation by jetting a pressurized fluid from the apparatus through a casing opening in the well casing and into the earth formation; receiving in the well casing through the casing opening fluid and formation debris created from forming the lateral bore; and lifting the fluid and formation debris received by the well casing upwardly through the well casing to the well surface.
METHOD AND APPARATUS FOR COMPLETION OF HEAVY OIL UNCONSOLIDATED SAND RESERVOIRS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of International Application No. PCT/IB2011/054841, filed Nov. 1, 2011, which is a non-provisional of U.S. Application No. 61/409, 622, filed Nov. 3, 2010.

FIELD OF THE INVENTION

[0002] The present invention relates generally to methods and systems for enhancing heavy oil productivity from unconsolidated sand reservoirs and, in illustrated embodiments thereof, more particularly relates to a method and apparatus for completion of heavy oil unconsolidated sand reservoirs.

BACKGROUND OF THE INVENTION

[0003] Heavy oil production with sand is becoming an increasingly used technique for certain types of heavy oil deposits. Allowing sand production can dramatically improve oil recovery compared to the non-sand production process. The advantage of allowing sand production is that the produced sand creates high permeability zones comprising of relatively small channels for the heavy oil to flow through. However, a challenge with heavy oil production with sand is keeping the sand moving freely and consistently into the wellbore.

[0004] Conventional, explosive charge well perforation or completion which creates relatively small diameter holes in the well casing for the production of formation fluid from the reservoir has experienced sporadic success with heavy oil production with sand. This is attributed to experiencing inflow problems caused by fine sand and clay migration or reservoir sand sloughing that plugs the small diameter casing holes created by the explosive charge perforation completion process.

[0005] In an attempt to improve well productivity, and to alleviate the plugging problems associated with conventional explosive charge perforation, horizontal drilling and horizontal radial water-jetting methods have been implemented in the completion of unconsolidated sand reservoirs. However, each of these methods has achieved nominal success. It is believed the low success is attributed to performing these methods in an overbalanced condition, that is, in a condition in which fluid pressure in the wellbore is maintained higher than the pressure of the reservoir. In this condition, sand loosened from the horizontal drilling and horizontal radial water-jetting is pushed back into the reservoir. It is believed this causes instability in the manufactured bores and results in eventual collapse or closure of the channel due to sand sloughing.

[0006] Considering the advantage of high permeability verse the challenge of high sand production in heavy oil unconsolidated sand reservoirs a need exists for an improved completion method and apparatus that provides an unrestricted near well-bore access in heavy oil sand producing wells. It is to this need that the present invention is directed.

SUMMARY OF THE INVENTION

[0007] In carrying out the principles of the present invention, in accordance with representative embodiments thereof, a well casing perforation and formation boring tool and methods of the same for the completion of a subterranean well, and particularly, a heavy oil unconsolidated sand reservoir in an underbalanced condition is provided.

[0008] Embodiments of the present invention also provide for a low impact completion when compared to conventional explosive charge completions, which alleviate concern of damaging cement encasement that is critical in providing isolation from water zones above or below the productive formation.

[0009] Embodiments of the present invention further provide tools and methods for forming a large well-bore access area and a high permeability lateral bore or cavern deep within the reservoir providing enhanced connection between the well and reservoir. The large sand face or reservoir contact area provided by the high permeability bore reduces reservoir fluid velocities and is believed to minimize or eliminate problematic sand and clay production.

[0010] Embodiments of the present invention further provide tools and methods that can be implemented on existing completed wells that are experiencing problematic inflow or poor production due to near well bore formation damage.

[0011] To achieve these and other advantages, in general, in one aspect, a method of completing a subterranean well extending through an earth formation is provided, including the steps of: creating an underbalanced condition in the well; providing a nozzle in the well; and pumping a pressurized fluid through the nozzle such that a jet of the pressurized fluid exits from the nozzle and impinges on the earth formation creating a lateral bore in the earth formation.

[0012] The method may further include the steps of: providing a flexible hose to which the nozzle is attached and extending the flexible hose fitted with the nozzle into the earth formation from the well.

[0013] In general, in another aspect, a method of completing a subterranean well having a well casing extending through an earth formation is provided, including the steps of: suspending an apparatus at a selected depth within the well casing; creating an unbalanced condition within the well casing; forming a lateral bore in the formation by jetting a pressurized fluid from the apparatus through a casing opening in the well casing and into the earth formation; receiving in the well casing through the casing opening fluid and formation debris created from forming the lateral bore; and lifting the fluid and formation debris received by the well casing upwardly through the well casing to the well surface.

[0014] In general, in another aspect, a method of completing a subterranean well having a well casing extending through an earth formation is provided, including the steps: providing a well perforation and completion tool including a body having a circumferential wall, an internal axial flow passage extending through an end of the body and terminating through the circumferential sidewall forming a side port, one or more lateral ports extending through the circumferential wall and providing fluid communication between the internal axial flow passage and a position exteriorly of the body, and an abrasive jet perforation nozzle disposed in each of the lateral ports; suspending the well perforation and completion tool at a selected depth within the well casing; pumping a high pressure abrasive fluid through the internal axial flow passage such that a jet of the high pressure fluid exits out of each of the perforation nozzles to form a perforation in the well casing; moving the well perforation and completion tool in the well casing while maintaining the azimuth position of the
well perforation and completion tool relative to the well casing while pumping the high pressure fluid to form a casing slot through the well casing; configuring the well perforation and completion tool for well completion; creating an unbalanced condition in the well casing; extending a hose having attached thereto an excavation nozzle from the apparatus through the side port and through the casing slot and into the earth formation; and pumping a pressurized excavation fluid through the hose such that the jet of the pressurized excavation fluid ejected out of the excavation nozzle impinges the earth formation to form a lateral bore in the earth formation while extending the hose.

[0015] In general, in another aspect, a casing perforation and formation boring tool for use in connection with the completion of a subsurface well is provided, the tool including: a body having a circumferential wall, an internal axial flow passage extending through an end of the body and terminating through the circumferential sidewall forming a side port, one or more lateral ports extending through the circumferential wall and providing fluid communication between the internal axial flow passage and a position exteriorly of the body, and a landing seat disposed across the internal axial flow passage at a position between the one or more lateral ports; the internal axial flow passage configured to receive a tube therein; the landing seat configured to receive a blanking plug to isolate the one or more lateral ports from the side port; and an abrasive perforation nozzle disposed in each of the one or more lateral ports.

[0016] In an aspect, the tool may also include a flexible hose disposed and extensible within the internal flow passage; a hydraulic excavation nozzle connected to a downhole end of the flexible hose; and a guide wheel guiding the distal end of the flexible hose through the side port.

[0017] In an aspect, the tool may also include a pipe disposed within the internal axial flow passage; a pipe coupling connect to an top hole end of the pipe; and a hydraulic excavation nozzles connected to a downhole end of the pipe, the hydraulic excavation nozzle aligned with the side port and configured to jet a stream of pressurized fluid flowing through the pipe.

[0018] In an aspect, the tool may also include an alignment tab carried by the body and extensible between a retracted position and an extended position.

[0019] There has thus been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated.

[0020] Numerous objects, features and advantages of the present invention will be readily apparent to those of ordinary skill in the art upon a reading of the following detailed description of presently preferred, but nonetheless illustrative, embodiments of the present invention when taken in conjunction with the accompanying drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of descriptions and should not be regarded as limiting.

[0021] As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based, may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

[0022] For a better understanding of the invention, its operating advantages and the specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The following drawings illustrate by way of example and are included to provide further understanding of the invention for the purpose of illustrative discussion of the embodiments of the invention. No attempt is made to show structural details of the embodiments in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. Identical reference numerals do not necessarily indicate an identical structure. Rather, the same reference numeral may be used to indicate a similar feature of a feature with similar functionality. In the drawings:

[0024] FIGS. 1A-C are cross-sectional views of successive axial portions of a well casing perforation and formation boring tool embodying principles of an embodiment the present invention, the tool being shown in a first configuration for well casing perforation;

[0025] FIGS. 2A-B are cross-sectional views of successive axial portions of the well casing perforation and formation boring tool of FIGS. 1A-C, the tool being shown in a second configuration for formation boring;

[0026] FIGS. 3A-C are cross-sectional views of successive axial portions of a well casing perforation and formation boring tool embodying principles of another embodiment the present invention, the tool being shown in a first configuration for well casing perforation;

[0027] FIGS. 4A-B are cross-sectional views of successive axial portions of the well casing perforation and formation boring tool of FIGS. 3A-C, the tool being shown in a second configuration for formation boring;

[0028] FIG. 5 is a schematic well diagram illustrating a method of perforating a well casing of a subsurface well, the method embodying principles of an embodiment of the invention;

[0029] FIG. 6 is a schematic well diagram illustrating a method of boring a channel into a subsurface formation from the well, the method embodying principles of an embodiment of the invention;

[0030] FIG. 7 is a diagrammatic perspective view of an exemplary hydraulic excavation nozzle;

[0031] FIG. 8 is a diagrammatic rear view of the hydraulic excavation nozzle of FIG. 7;

[0032] FIG. 9 is a schematic tool diagram embodying principles of an embodiment the present invention; and

[0033] FIG. 10 is a schematic tool diagram embodying principles of an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0034] As a preliminary matter, it should be noted that in this document (including the claims) directional terms, such as “above”, “below”, “upper”, “lower”, etc., are used for convenience in referring to the accompanying drawings.
Additionally, it is to be understood that the various embodiments of the invention described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., without departing from the principles of the invention.

Representatively illustrated in FIGS. 1A-C is a well casing perforation tool and formation boring tool 10 in accordance with an embodiment of the invention. Tool 10 is shown in a well casing perforation configuration and includes a tool body 12 having an abrasive jet perforation sub 14, a landing nipple 16, a jetting shoe 18 and a wiper sub 20 each disposed coaxially and in series from the abrasive jet perforation sub to the wiper sub. Body 12 further includes an internal axial flow passage 22 extending through the abrasive jet perforation sub 14, the landing nipple 16 and partially through the jetting shoe 18 where the internal axial flow passage includes a lateral bend and extends through the circumferential wall of the jetting shoe forming a side port 24.

The abrasive jet perforation sub 14 has at least one, and preferably has a plurality of lateral ports 26 extending through the circumferential wall thereof. In one embodiment, there are three lateral ports 26 arranged in a triangular configuration. In another embodiment, there are four lateral ports 26 arranged in a boxed or diamond configuration. The lateral ports 26 provide fluid communication between the internal axial flow passage 22 and a position exteriorly of the abrasive jet perforation sub 14. An abrasive jet perforation nozzle 28 is disposed in each of the lateral ports 26 for the passage of the high pressure abrasive cutting fluid used to cut a slot into the well casing and cement encasement as will be further described below. Lateral ports 26 and nozzles 28 are preferably configured to cut a one-inch wide slot through the well casing and cement encasement.

Further, it is of importance to note, the lateral ports 26 and the side port 24 are disposed on the same side of body 12 and are generally vertically aligned about the circumference of the body.

Landing nipple 16 connects the abrasive jet perforation sub 14 and the jetting shoe 18 and provides a landing seat 30 across the internal axial flow passage 22 for the reception of a removable blanking plug 40 to seal the internal axial flow passage and isolate the jetting shoe from a flow of fluid through the internal axial flow passage in a well casing perforation operation as will be described in further detail below. The blanking plug 40 may include a fishing neck 41 to permit retrieval of the blanking plug through known methods.

Jetting shoe 18 is configured to receive the passage of an extensible hydraulic excavator (FIGS. 2A-C) that includes a flexible high pressure hose fitted with a high pressure fluid nozzle that is run-in from the well surface in a formation boring operation as will be described in further detail below. The jetting shoe 18 includes a hose guide wheel 32 that is rotatably supported by the body 12 and partially intersects with the internal axial flow passage 22. The guide wheel 32 serves to guide the flexible high pressure hose run through the internal flow passage 22 with the side port 24 where it can be extend through the side port and into the formation during said formation boring operation.

Jetting shoe 18 further includes an extensible alignment tab 34 that laterally moves relative to the jetting shoe between a retracted position, shown in FIG. 2, and an extending position for registration with a perforation slot cut into the well casing by the abrasive jet perforation sub 14 during said well casing perforation operation. In an embodiment, the alignment tab 34 is biased into the extended position. The alignment tab 34 may be spring biased by one or more coil springs 36. In a preferred embodiment, alignment tab 34 is disposed vertically below side port 24 with reference to the orientation of the tool 10 as illustrated in the figures. It is important to note, alignment tab 34 is located along the same side of body 12 as the lateral ports 26 and the side port 24 and is generally vertically aligned about the circumference of the body with the lateral ports and the side port.

Wiper sub 20 is attached to the bottom of the jetting shoe 18 and includes one or more radially extending seal members 38. The seal member 38 is configured to make a circumferential sealing contact with the internal surface of the well casing and provides well casing isolation from lower completion zones.

In FIGS. 2A-B, tool 10 is illustrated in a second configuration which is a formation boring configuration, wherein the blanking plug 40 is removed and an extensible hydraulic excavator 42 is disposed in the internal axial fluid passage 22. The extensible hydraulic excavator 42 includes a high pressure flexible hose 44 having a hydraulic excavation nozzle 46 fitted at its distal end and is connected at the opposite end to a coiled tubing 48. The high pressure flexible hose 44 is disposed about guide wheel 32 with the hydraulic excavation nozzle 46 aligned with side port 24. As will be further described, advancement of the coiled tubing 48 at the surface of the well causes the high pressure flexible hose 44 to extend from the jetting shoe 18 through side port 24 as illustrated in dashed line. Similarly, retraction of the coiled tubing 48 causes the high pressure flexible hose 44 to retract into the jetting shoe 18. Rotating guide wheel 32 ensures the high pressure flexible hose 44 is extended and retracted through side port 24 without being kinked or snagged by the jetting shoe 18.

An alternate embodiment 18a of the jetting shoe 18 is shown in FIGS. 3A-C and is incorporated in an alternate embodiment 10a of the previously described tool 10. In FIGS. 3A-C, tool 10a is illustrated in the well casing perforation configuration. Further, like reference numbers refer to similar elements of the embodiments, and accordingly, to avoid duplication will not be described here. Jetting shoe 18a is devoid of guide wheel 32 and opposed to an extensible hydraulic excavator, jetting shoe 18a is fitted a fixed hydraulic excavator 50 that is disposed through internal axial flow passage 22. Fixed hydraulic excavator 50 includes a fixed stand pipe 52 fitted at the top or surface end with a coil on/off tool 54 and at the opposite end a high pressure hydraulic excavation nozzle 56. The coil on/off tool 54 permits the downhole connection of a coiled tube with the stand pipe 52 for the delivery of a high pressure fluid to the excavation nozzle 56. The excavation nozzle 56 is fixedly disposed at side port 24 and is directed to eject a high pressure stream from the side port towards the formation in a formation boring operation.

In FIGS. 4A-B, tool 10a is illustrated in a second configuration which is a formation boring configuration, wherein the blanking plug 40 is removed and the stand pipe 52 of the fixed hydraulic excavator 50 is connected by coil on/off tool 54 to a length of coiled tubing 58 run into the internal axial flow passage 22.

Turning now to FIG. 5, well casing perforation will be described utilizing tool 10 configured in the well casing perforation configuration that is illustrated in FIGS. 1A-C and discussed above. In FIG. 5, there is schematically illustrated a conventional well bore 60 having a well casing 62 and
cement encasement 64 extending through an oil bearing formation 66, and particularly, a heavy oil unconsolidated sand formation. Tool 10 is schematically illustrated for purpose of illustrative clarity, and is connected to a distal end of a length of upset tubing 68 or the like at the top end of the abrasive jet perforation sub 14. Tool 10 is lowered into the well casing 62 by tubing 68 to a depth at which it is desired to perforate the well casing and the cement encasement 64 and complete a lateral bore into the adjacent formation 66. Once the tool 10 is positioned at the desired depth, a high pressure abrasive fluid 70 is pumped through tubing 68 and into the internal axial flow passage 22 of the tool. The Blanking plug 40 isolates the jetting shoe 18 from the abrasive jet perforation sub 14 causing the high pressure abrasive fluid 70 to flow through lateral ports 26 and jet out from the perforation nozzles 28 under high pressure and impinge against the wall of the well casing 62 and cement encasement 64. Tool 10 is then alternately moved upwardly (withdrawn) and downwardly (extended) in the well casing 62 to cut a casing slot 72 through the well casing and cement encasement 64. Tool 10 is moved a distance corresponding to the desired overall height of the casing slot 72. Once the casing slot 72 is cut, tool 10 is configured for formation boring by the retrieval of blanking plug 40 for example, by running length of coiled tubing (not shown) through tubing 68 to connect to the blanking plug and withdraw it from tool 10 and pull it to the surface, thereby permitting running of the extensible hydraulic excavator.

[0046] Turning now to FIG. 6, formation boring will be described utilizing tool 10 configured in the formation boring configuration that is illustrated in FIGS. 2A-B and discussed above. Tool 10 is schematically illustrated for purpose of illustrative clarity, and remains connected to tubing 68. Tool 10 is moved upwardly (withdrawn) in the well casing 62 causing guide tab 34, which is pressed against the interior surface of the well casing via the biasing force of springs 36, to automatically extend into and engage casing slot 72 (as shown here). The engagement of the guide tab 34 with the casing slot 72 registers the side port 24 of the jetting shoe 18 with the casing slot.

[0047] With the guide tab 34 in this position, the extensible hydraulic excavator 42 is connected to tubing 48 and comprising hose 44 and nozzle 46 is run-in through tubing 68 and internal axial flow passage 22. Upon the nozzle 46 reaching the guide wheel 32, the nozzle and the hose 44 are fed through the side port 24 and through the casing slot 72, at which it is positioned and oriented laterally against the formation 66 in which a lateral bore radially extending from the well bore 60 is to be completed.

[0048] At this point, the well bore 60 is placed into an underbalanced condition, wherein the pressure within the well casing 62 is lower than the formation pressure, by a continuous injection of stable foam through tubing 68 and the internal axial flow passage 22 where it is ejected from the side port 24. The stable foam 74 is returned to the surface through well casing 62. Once the stable foam 74 is initially returned to the surface, pressurized fluid, such as, for example water is then pumped through tubing 48, through hose 44 and jetted from nozzle 46 where it impinges against the unconsolidated sand formation 66 forming a lateral bore 76 therein. The underbalanced condition of the well bore 60, as result of the injection of stable town 74, causes sand slurry and fluids, admixed with the stable foam, to flow outwardly from the lateral bore 76 and into the well casing 62 through the casing slot 72. Once in the well casing 62, the sand slurry, fluid and stable foam are further mixed within a mixing chamber 78 defined by a lateral recessed profile 80 in the exterior circumferential wall of the jetting shoe 18 and the well casing 72. The recessed profile 80 is further illustrated in FIG. 1B by the region bounded by the dashed lines. At this point, the stable foam, sand and fluid slurry is lifted to the surface of the well bore 60.

[0049] The hose 44 and nozzle 46 are fed continuously into the unconsolidated sand formation 66 from the tool 10 until a lateral bore 76 reaches a desired radial depth from the well bore 60. The hose 44 and nozzle 46 may be alternately withdrawn and extended (guided by guide wheel 32) to achieve the desired radial depth, which may be up to 150-feet. As this operation continues, an increasing volume of sand is flushed into the well casing 62 creating a high permeability bore 76 deep into the unconsolidated sand formation 66.

[0050] Once bore 76 reaches a desired depth, water jetting injection is terminated, and the hose 44 and nozzle 46 are withdrawn into the jetting shoe 18 and the excavator 42 is withdrawn from tool 10 and pulled to the surface. Stable foam injection continues until the surface returns are clear of sand providing an indication that completion at this interval is finished, and at which point, the stable foam injection is terminated. Tool 10 is then withdrawn slowly causing the alignment tab 34 to be retracted once it reaches the top of the casing slot 72. Tool 10 may be withdrawn a certain distance to align the tool with another completion zone or may be completely withdrawn from the well bore 60. In multiple completions with tool 10, the lowest or deepest zone would be completed first with successive zones being completed at the tool is withdrawn. The wiper sub 20 isolates completed zones as the tool 10 is withdrawn and is operated to complete a subsequent zone.

[0051] The above description in reference to methods of operating tool 10 and the above description of tool 10a with reference to FIGS. 3A-C and FIGS. 4A-B are believed to be sufficient to understand the operation of tool 10a. The main distinction being the fixed excavator 50 of tool 10a is disposed within the internal axial flow passage 22 prior to tool 10a being run-in to the well casing 62. Of course, the fixed excavator 50 does not extend a hose or excavation nozzle radially into the formation as does the extensible excavator 42 of tool 10a. Accordingly, tool 10 is considered to be primarily used for deep formation penetration and tool 10a is considered to be primarily used for shallow formation penetration.

[0052] Further, it should be noted excavation nozzles 46 and 56 may be of any known type or conventional in the art. In an embodiment, and for example, as illustrated in FIGS. 7 and 8, nozzle 46 may include one more thrust discharge ports 78 disposed on a rearward end of the nozzle. Thruster discharge ports 78 operate to jet streams of fluid from the nozzle 46 in a rearwardly direction relative to the nozzle which causes the nozzle 46 to be propelled in a forwardly direction. Nozzle 46 also includes one or more excavation discharge ports 80 disposed on a forward end of the nozzle. Ports 80 operate to jet streams of fluid from the nozzle 46 in a forwardly direction relative to the nozzle for the purpose of hydraulic excavating material disposed forward of the nozzle.

[0053] With reference to FIG. 9, the jetting shoe 18 can be configured to be run-in separately of the abrasive perforation sub 14 and the nipple 16, in restoring or cleaning operations in existing wells to improve well production by cleaning casing perforations or further opening of formation bores. In such a configuration, tubing 68 would be connected to the
jetting shoe 18 to lower the jetting shoe in the well casing to the desired depth. Extensible excavator 42 would be operated as discussed above, in either an underbalanced or overbalanced well condition. Jetting shoe 18a can be configured similarly to jetting shoe 18 as shown in FIG. 10.

[0054] A number of embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.

What is claimed is:

1. A method of completing a subterranean well extending through an earth formation, the method comprising the steps of:
   - creating an underbalanced condition in the well;
   - providing a nozzle in the well; and
   - pumping a pressurized fluid through said nozzle such that a jet of said pressurized fluid ejects from said nozzle and impinges on the earth formation creating a lateral bore in the earth formation.

2. The method of claim 1, further comprising:
   - providing a flexible hose to which said nozzle is attached; and
   - extending said flexible hose fitted with said nozzle into the earth formation from the well.

3. The method of claim 1, wherein the step of creating includes:
   - injecting a stable foam into the well.

4. A method of completing a subterranean well having a well casing extending through an earth formation, the method comprising the steps of:
   - suspending an apparatus at a selected depth within the well casing;
   - creating an unbalanced condition within the well casing;
   - forming a lateral bore in the formation by jetting a pressurized fluid from said apparatus through a casing opening in the well casing and into the earth formation;
   - receiving in the well casing through the casing opening fluid and formation debris created from forming said lateral bore; and
   - lifting the fluid and formation debris received by the well casing upwardly through the well casing to the well surface.

5. The method of claim 4, wherein said step of creating includes:
   - injecting stable foam into the well casing.

6. The method of claim 5, wherein said stable foam is injected from said apparatus.

7. The method of claim 4, wherein said forming step includes:
   - extending a hose having attached thereto an excavation nozzle from said apparatus and through the casing opening and into the earth formation.

8. A method of completing a subterranean well having a well casing extending through an earth formation, the method comprising the steps of:
   - suspending an apparatus at a selected depth within the well casing;
   - creating an underbalanced condition in the well casing;
   - forming a longitudinal casing slot through the well casing by jetting a high pressure abrasive fluid from said apparatus at said well casing to make a perforation in the well casing while translating said apparatus in one of a withdrawal or extending direction in the well casing;
   - forming a lateral bore in the formation by jetting a pressurized fluid from said apparatus through said casing slot and into the earth formation;
   - receiving in the well casing through the casing slot fluid and formation debris created from forming said lateral bore; and
   - lifting the fluid and formation debris received by the well casing upwardly through the well casing to the well surface.

9. The method of claim 8, wherein said step of creating includes:
   - injecting stable foam into the well casing.

10. The method of claim 9, wherein said stable foam is injected from said apparatus.

11. The method of claim 8, wherein said forming step includes:
   - extending a hose having attached thereto and excavation nozzle from said apparatus and through the casing opening and into the earth formation.

12. A method of completing a subterranean well having a well casing extending through an earth formation, the method comprising the steps of:
   - providing a well perforation and completion tool including a body having a circumferential wall, an internal axial flow passage extending through an end of said body and terminating through said circumferential sidewall forming a side port, one or more lateral ports extending through said circumferential wall and providing fluid communication between said internal axial flow passage and a position exteriorly of said body, and an abrasive jet perforation nozzle disposed in each of said lateral ports;
   - suspending said well perforation and completion tool at a selected depth within the well casing;
   - pumping a high pressure abrasive fluid through said internal axial flow passage such that a jet of said high pressure fluid ejects out of each of said perforation nozzles to form a perforation in the well casing;
   - moving said well perforation and completion tool in the well casing while maintaining the azimuth position of said well perforation and completion tool relative to the well casing while pumping said high pressure fluid to form a casing slot through the well casing;
   - configuring said well perforation and completion tool for well completion;
   - creating an underbalanced condition in the well casing;
   - extending a hose having attached thereto an excavation nozzle from said apparatus through said side port and through said casing slot and into the earth formation; and
   - pumping a pressurized excavation fluid through said hose such that a jet of said pressurized excavation fluid ejects out of said excavation nozzle and impinges the earth formation to form a lateral bore in the earth formation while extending said hose.

13. The method of claim 12, wherein said step of creating includes:
   - pumping a stable foam through said internal axial flow passage such that said stable foam exits said side port and into the well casing.

14. The method of claim 12, further comprising the step:
   - engaging a guide tab with said casing slot to align said side port with said casing slot.

15. The method of claim 14, wherein said engaging step includes:
   - guide tab extends from said body and into said casing slot.
16. A casing perforation and formation boring tool for use in connection with the completion of a subterranean well, the tool comprising:
a body having a circumferential wall, an internal axial flow passage extending through an end of said body and terminating through said circumferential sidewall forming a side port, one or more lateral ports extending through said circumferential wall and providing fluid communication between said internal axial flow passage and a position exteriorly of said body, and a landing seat disposed across said internal axial flow passage at a position between said one or more lateral ports;
said internal axial flow passage configured to receive a tube therein;
said landing seat configured to receive a blanking plug to isolate said one or more lateral ports from said side port; and
an abrasive perforation nozzle disposed in each of said one or more lateral ports.
17. The tool of claim 16, further comprising:
a well casing isolation seal carried by said body at a position downhole end from said side port.
18. The tool of claim 16, further comprising:
a flexible hose disposed and extensible within said internal flow passage;
a hydraulic excavation nozzle connected to a downhole end of said flexible hose; and
a guide wheel guiding said distal end of said flexible hose through said side port.
19. The tool of claim 16, further comprising:
a pipe disposed within said internal axial flow passage;
a pipe coupling connect to an uphole end of said pipe; and
a hydraulic excavation nozzles connected to a downhole end of said pipe, said hydraulic excavation nozzle aligned with said side port and configured to jet a stream of pressurized fluid flowing through said pipe.
20. The tool of claim 16, further comprising:
an alignment tab carried by said body and extensible between a retracted position and an extended position.
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