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(54) WELLBORE CLEANOUT SYSTEM

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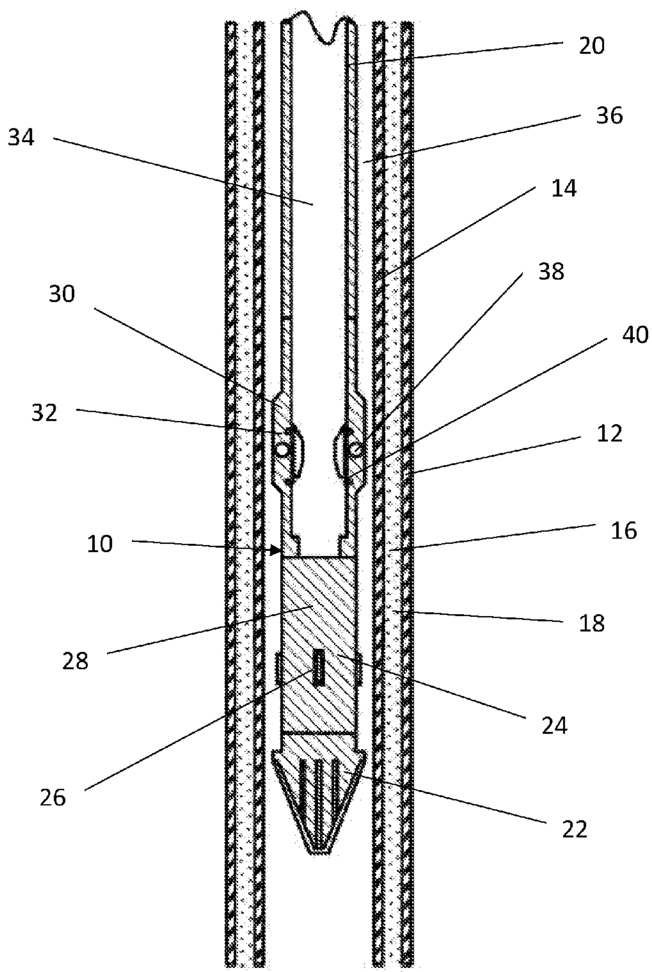
(57) ABSTRACT

A system of cleaning a portion of the casing prior to a plugging operation may include a centralizer, a first radially extendable cutting tool, a second radially extendable cutting tool, a preliminary extendable cleaning tool, and a fluid jet cleaning tool. In a preferred embodiment a centralizer, a radially extendable cutting tool, and a fluid jet cleaning tool are run into a wellbore where the radially extendable cutting tool cut the window through the inner production tubular and the fluid jet cleaning tool removes the remaining's cement and other debris allowing a plug to be placed within the window. In another embodiment a centralizer and a first extendable cutting tool may be run into the well where a small window is cut and then the centralizer first extendable cutting tool are removed from the wellbore. A centralizer, a second extendable cutting tool, and a fluid jet cleaning tool a run into the wellbore. The second extendable cutting tool is located adjacent the initial small window and the window is extended. The fluid jet cleaning tool removes the remaining cement and debris.



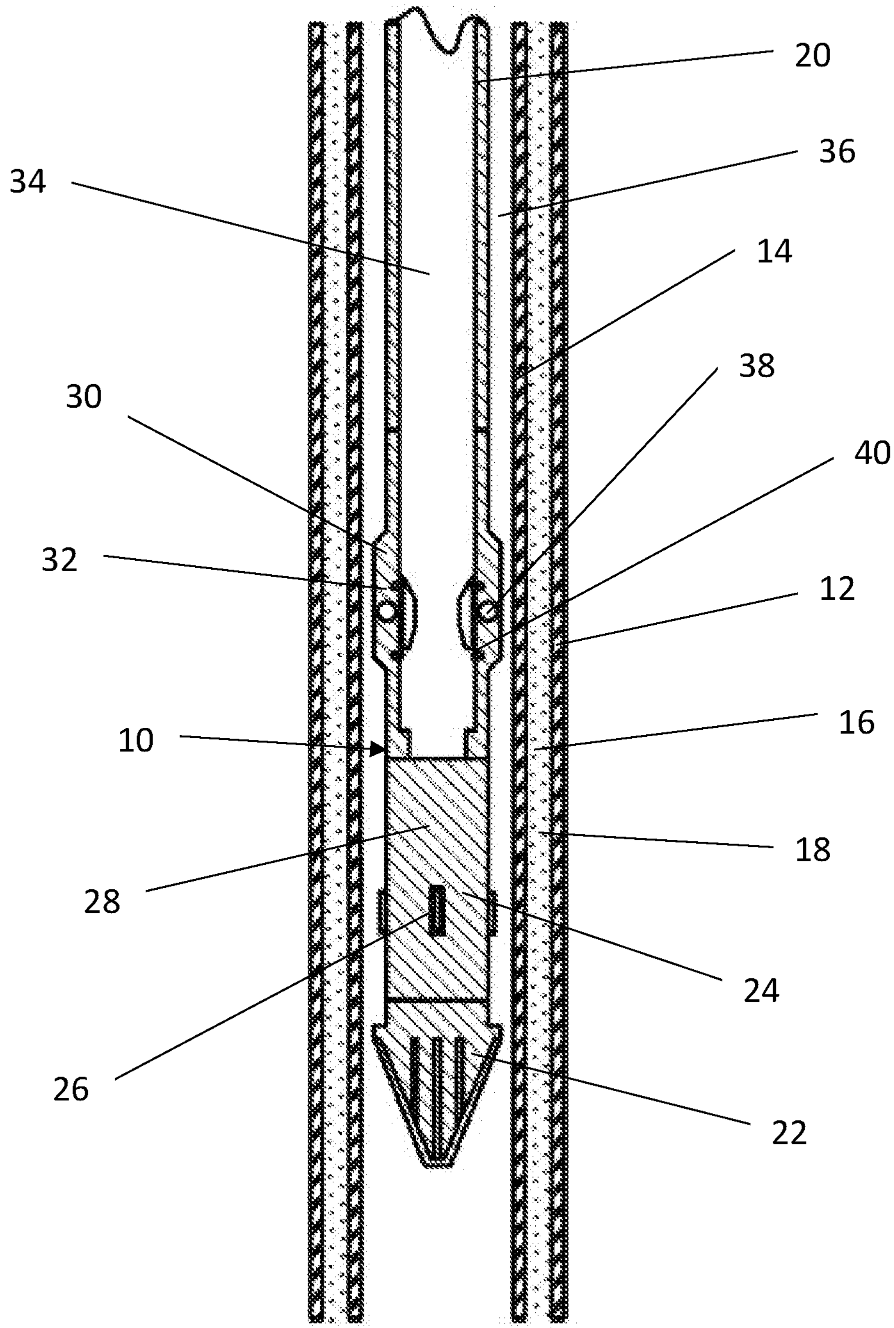


Figure 1

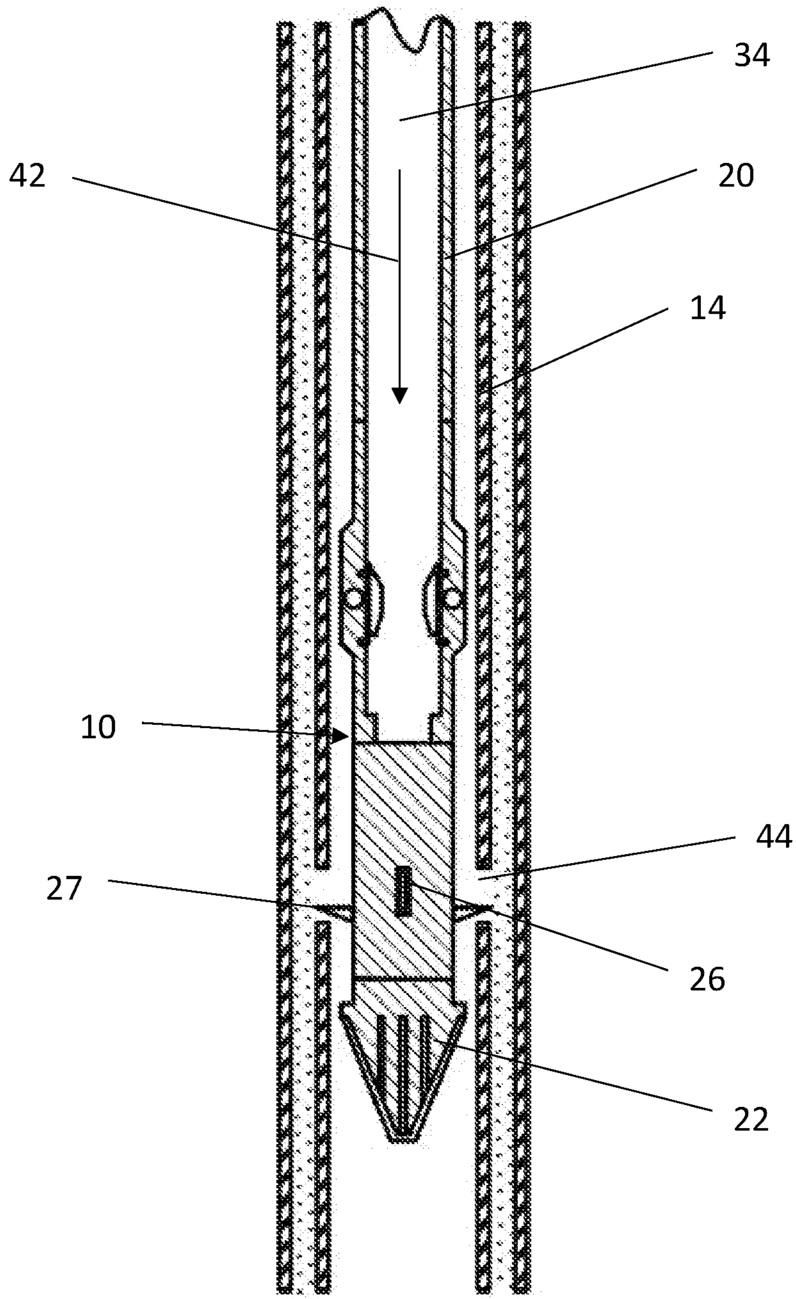


Figure 2

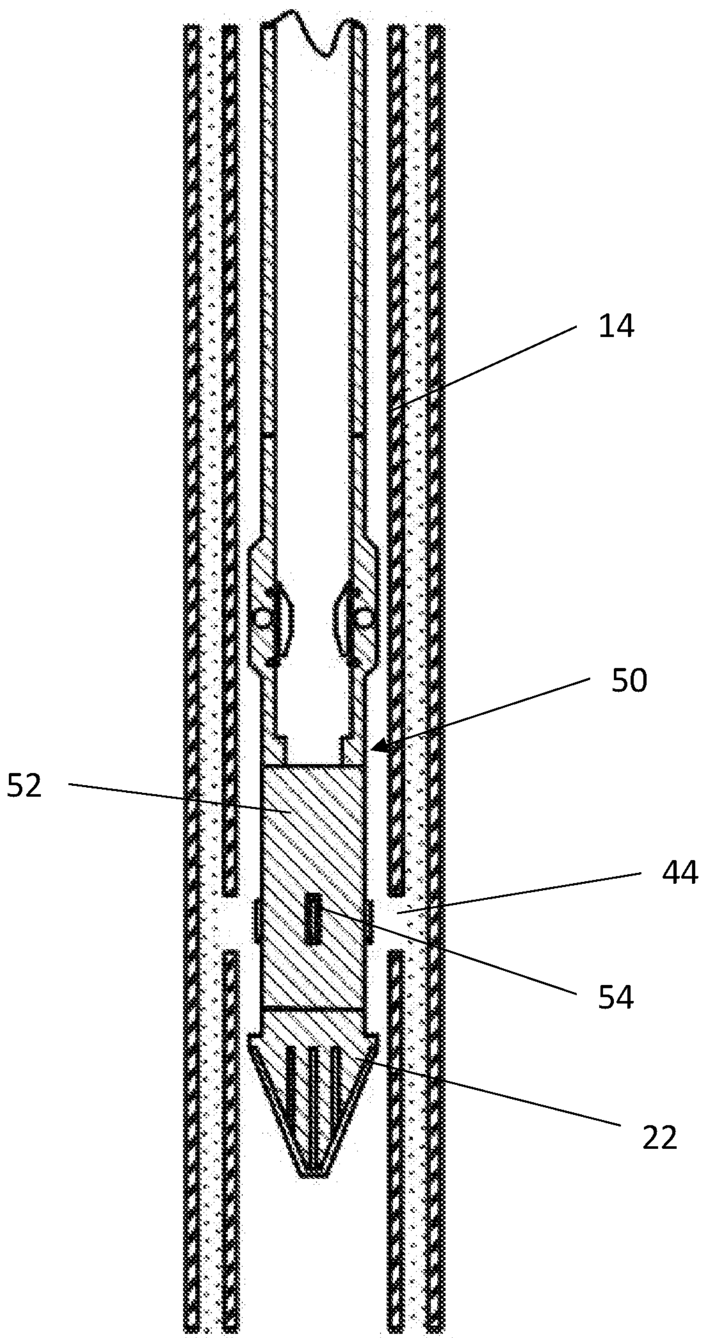


Figure 3

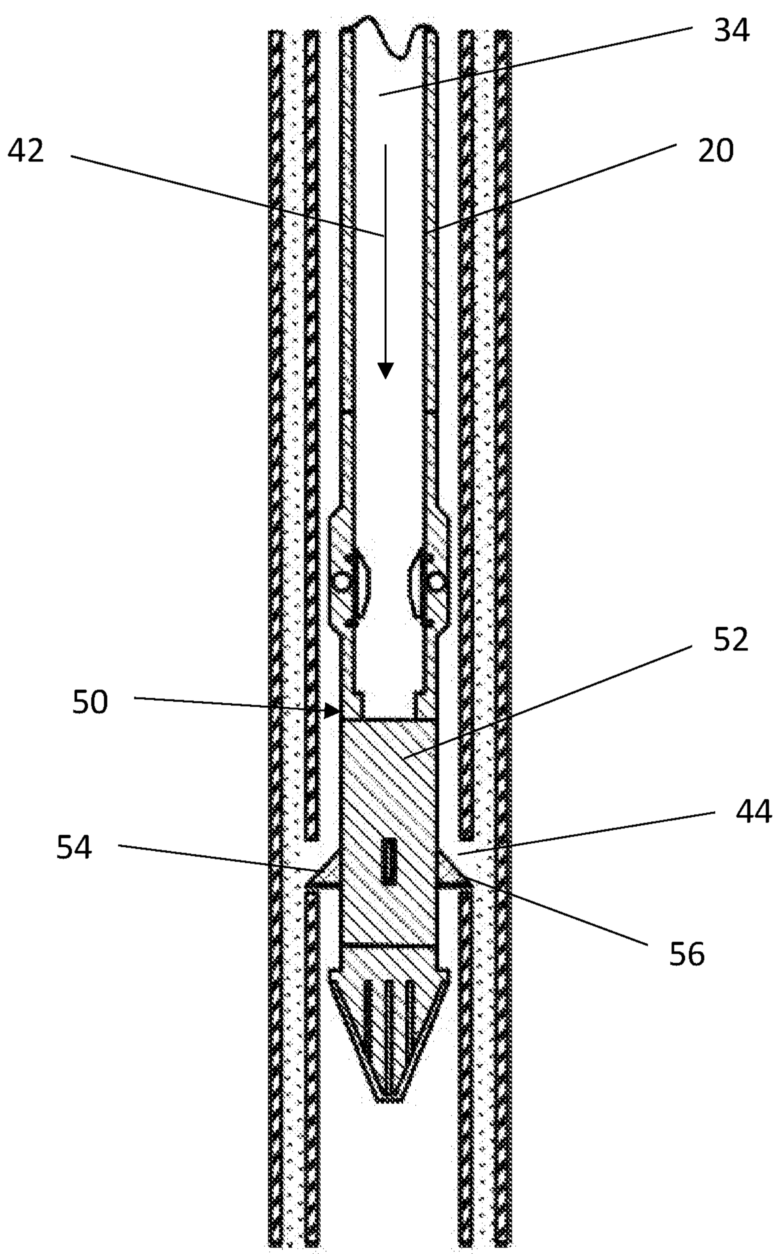


Figure 4

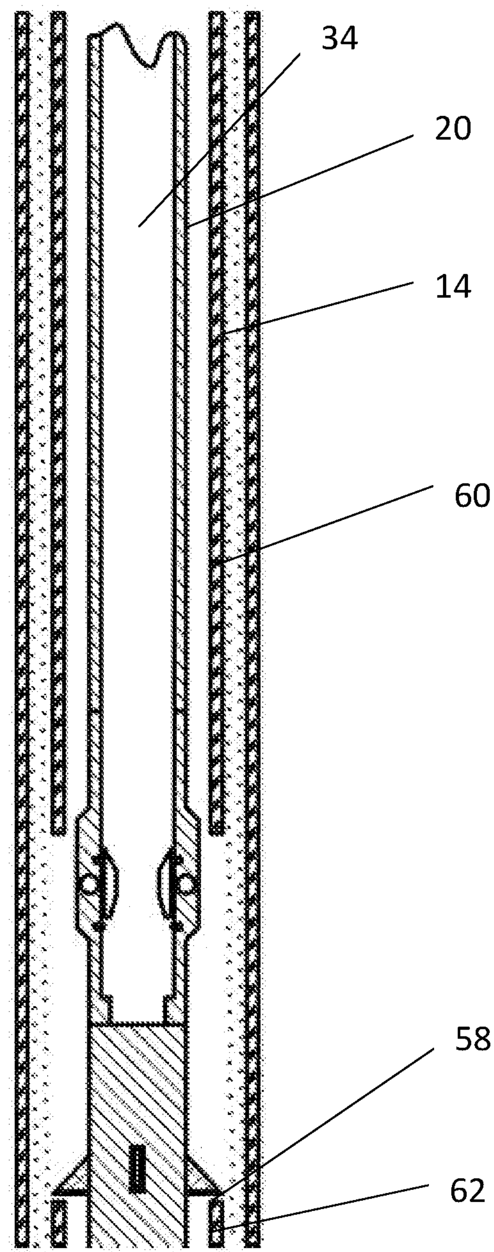


Figure 5

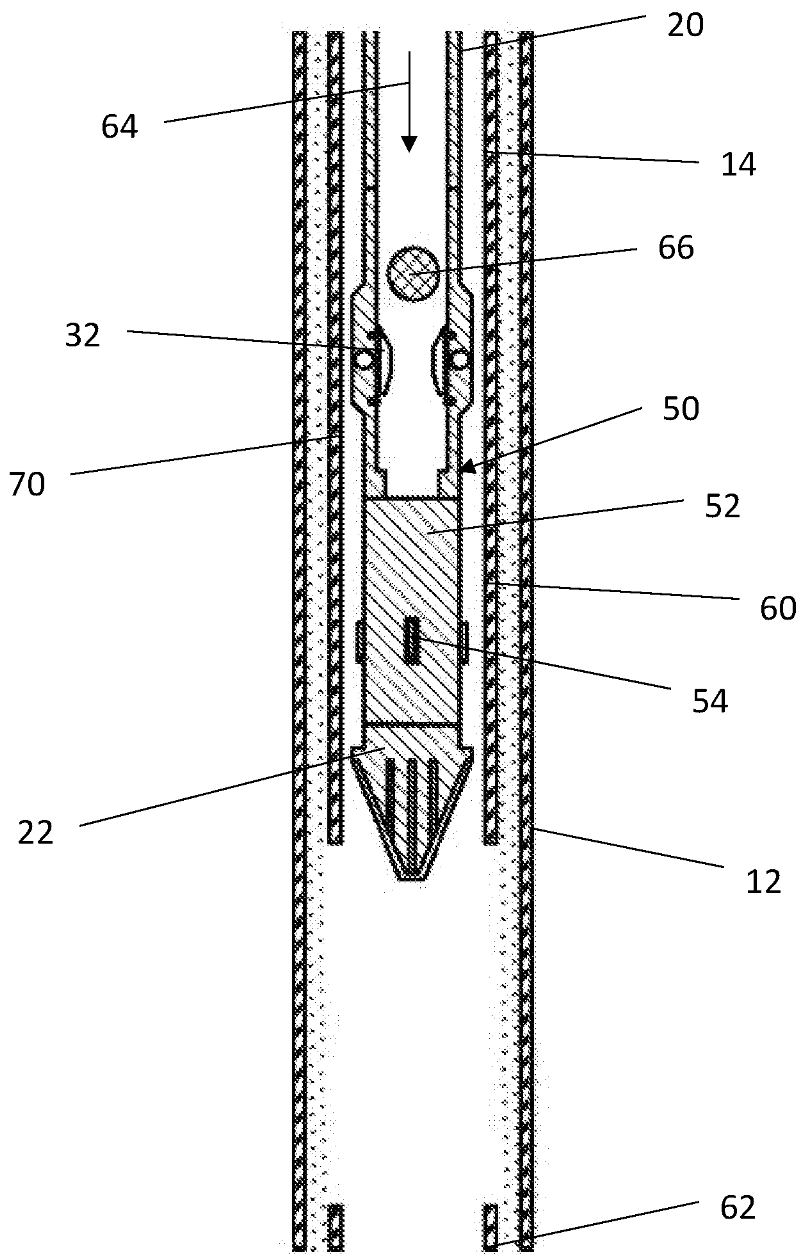


Figure 6

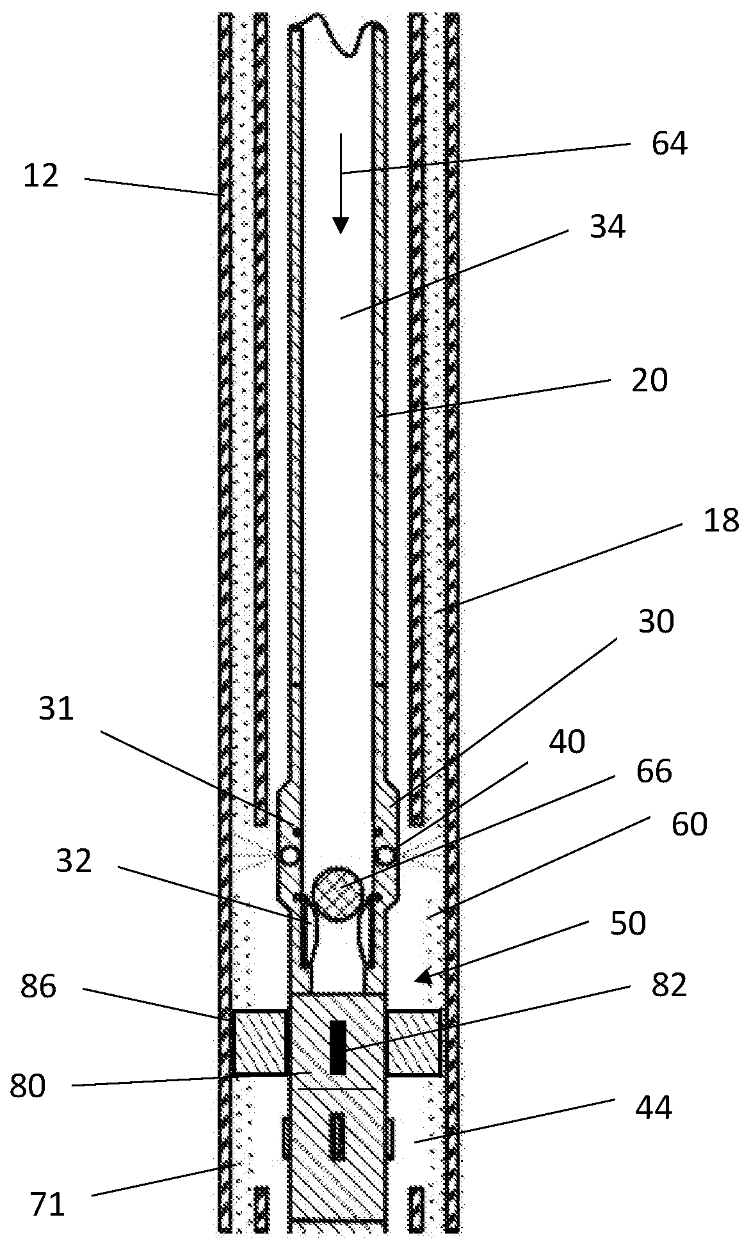


Figure 7

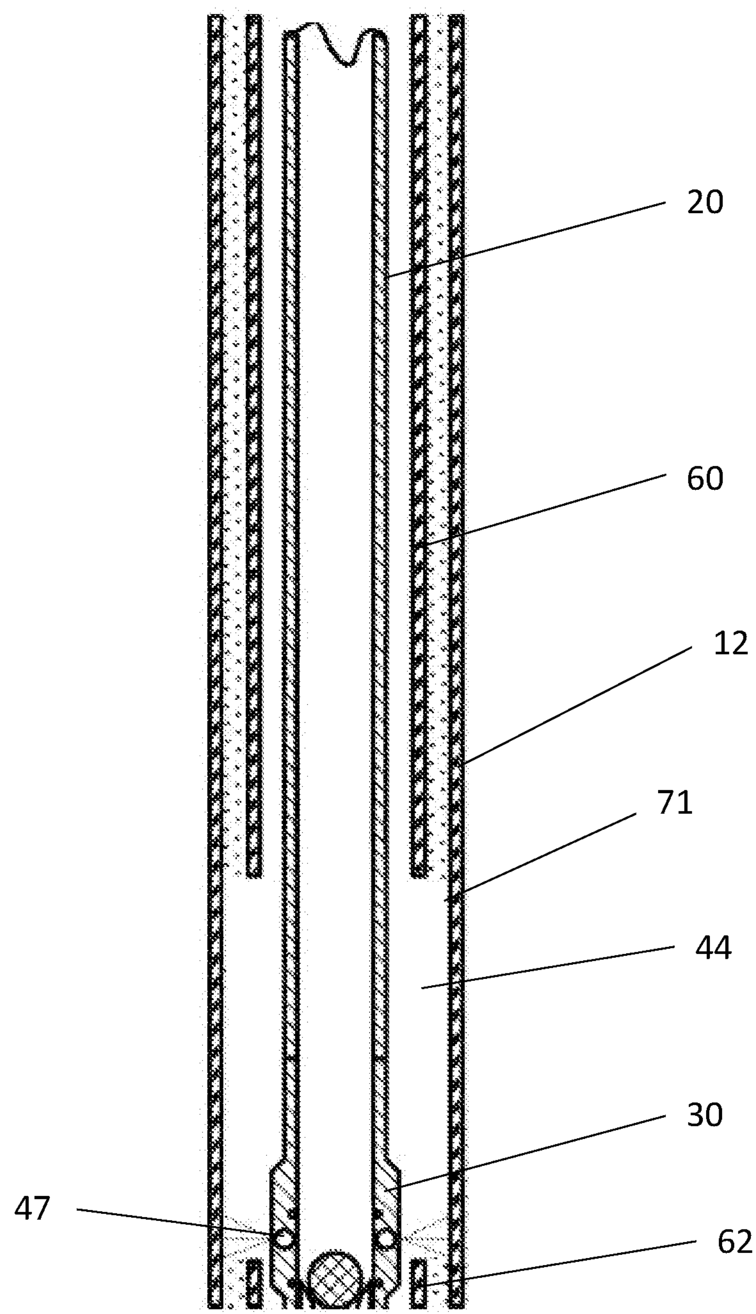


Figure 8

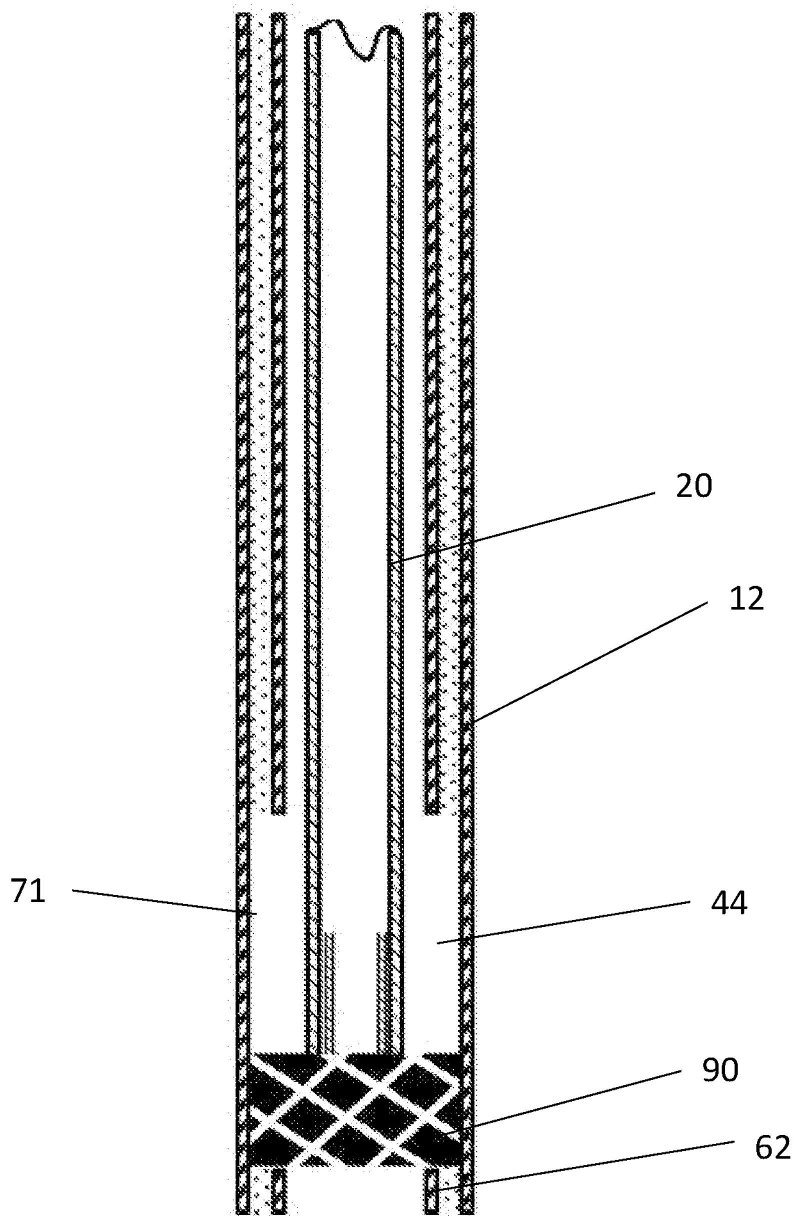


Figure 9

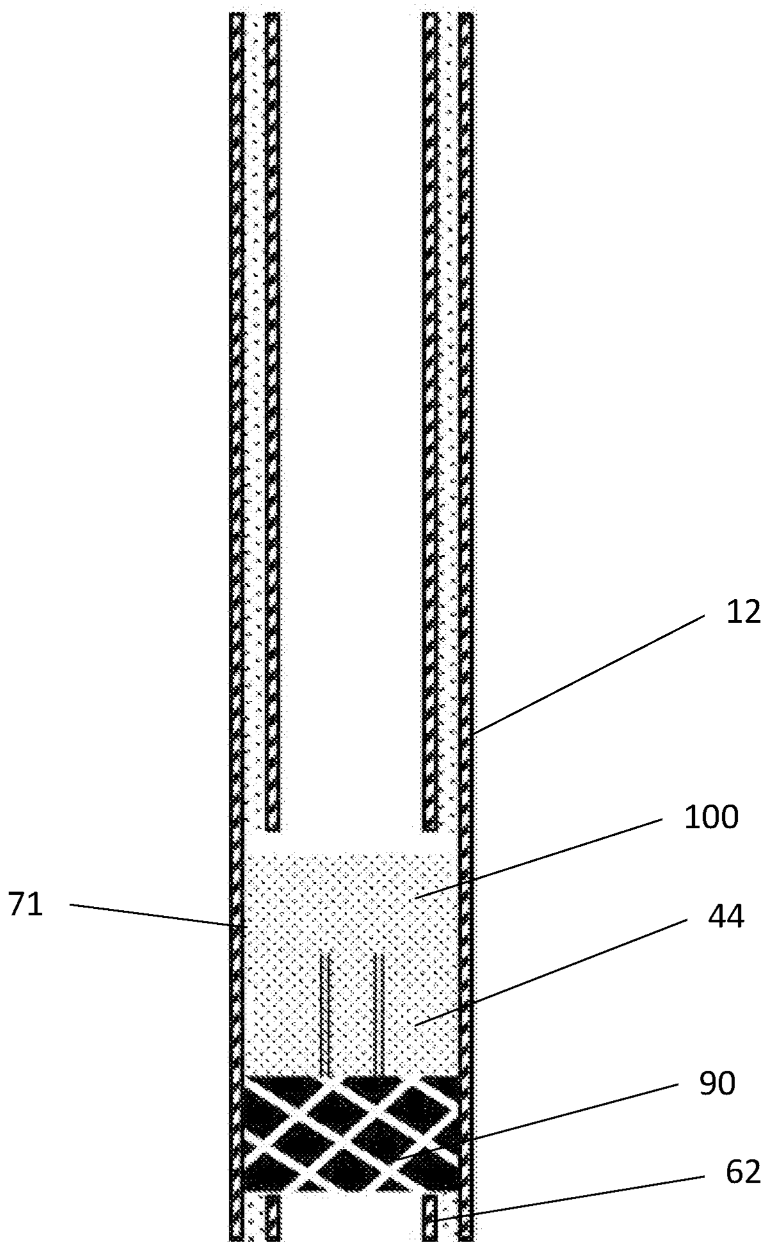


Figure 10

WELLBORE CLEANOUT SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a method of cleaning the internal casing prior to plugging a well in order to facilitate either permanent or temporary abandonment of the well.

BACKGROUND

[0002] Wells may be drilled for many purposes including oil and gas or water production, as the well reaches the end of its life it may be necessary to seal these wells.

[0003] A well is typically constructed by drilling a hole into the target zone such as a hydrocarbon producing reservoir. Initially, a drilling rig is brought to the well site and drilling begins. At some point a pipe, usually referred to as a tubular, and usually steel, is placed into the well. The tubular is referred to as a casing and provides structural integrity to the wellbore and/or seals various zones one from another within the wellbore. Usually when the casing is installed in the well, the casing is placed within the wellbore and then cement is forced down through the interior of the casing where it rises back up around the exterior annular zone between the casing and the borehole.

[0004] In many wells, part of the initial completion process includes installing a second tubular which may be referred to as a production casing or intermediate casing within the exterior casing. As with the casing, the production casing or intermediate casing is installed within the casing and then cement is pumped down the interior of the production casing or intermediate casing so that the cement then flows up in the annular region between the production casing or intermediate casing and the casing thereby cementing the production casing or intermediate casing within the casing.

[0005] At the end of the well's life, it is time to plug the well therefore a well barrier must be established across the full cross-section of the well. This is generally achieved by first removing the tubulars or a section of the tubulars from the wellbore. Well barriers are then established to isolate the reservoir and prevent flow between subsurface reservoir and between any subsurface reservoirs and the surface. Usually the well barrier is a plug with cement on top.

[0006] An improperly abandoned well is a serious liability, therefore it is important to ensure that the well is adequately plugged and sealed. However, the need for a drilling rig where time-consuming, multiple trips are required into and out of the well as each step is conducted results in high costs at a time when the well no longer generates revenue.

SUMMARY

[0007] An alternative approach to plugging a well incorporates all of the necessary steps to remove the desired portion of tubular and prepare the casing so that a mechanical plug may both grip and seal the well prior to the placement of the permanent plug. Generally the method involves placing onto a tubular and running into the hole an assembly that consists of all of the equipment required to centralize the equipment, cut into the production casing or intermediate casing without cutting the casing, and removing any material in the annular area between the production casing or intermediate casing and the casing.

[0008] The cleanout assembly may include a taper mill placed at the very bottom of the assembly. The taper mill is used to deburr or otherwise remove any debris or obstructions within the production casing or intermediate casing as the assembly is run into the wellbore and more importantly the taper mill is used to centralize the assembly within the production casing or intermediate casing. In certain instances the taper mill may be replaced with a rigid centralizer or other tool as long as the tool will centralize the assembly within the production casing or intermediate casing.

[0009] Above the taper mill, a multi-string cutter or similar tool may be placed into the assembly. The multi-string cutter has extendable blades where the extendable blades are retracted within the tool as the tool is run within the wellbore. Upon locating the multi-string cutter at the desired location a previously preset fluid flow through the multi-string cutter will extend the extendable blades into contact with the production casing or intermediate casing. The multi-string cutter is then rotated as at least the previously preset rate of fluid flows through the tool so that the extendable wings remain extended in order to cut into the production casing or intermediate casing. As the rotation and fluid flow continue the multi-string cutter cuts through the production casing or intermediate casing. Generally upon rotation of the multi-string cutter, the weight of the tubular connecting the assembly to the surface is set down on the multi-string cutter so that as the extendable wings cut circumferentially into the production casing or intermediate casing they will also cut longitudinally into the production casing or intermediate casing. Generally the extendable wings on the multi-string cutter are configured to be most efficient at cutting radially outward into the production casing or intermediate casing so that as the multi-string cutter rotates it cuts circumferentially into the production casing or intermediate casing, ultimately severing the production casing or intermediate casing one portion from the other. Once the multi-string cutter has severed the production casing or intermediate casing and removed a small longitudinal portion of the production casing or intermediate casing, in some instances only 6 to 12 inches, thereby creating a preliminary window within the production casing or intermediate casing, the multi-string cutter is disabled.

[0010] With the multi-string cutter disabled, a section mill or similar tool assembly is moved into position such that the section mill extendable wings are located within the preliminary window in the production casing or intermediate casing that was created by the multi-string cutter. With the section mill extendable wings located within the window, fluid flow within the tubular is again increased to a predetermined amount causing the section mill extendable wings to extend outwardly into the window. With the section mill wings extended, the assembly is rotated and weight set is down on the assembly so that the section mill wings land on the upper end of the remaining lower piece of production casing or intermediate casing. As the assembly is rotated with weight upon it, the section mill is able to extend the length of the window as desired. Upon creation of the extended window, the section mill is disabled.

[0011] With the section mill disabled, the first cleanout tool is moved into position at the top of the window. The first cleanout tool includes extendable wings; however in this instance, the extendable wings are specifically configured to prevent the extendable wings from being able to cut into the parent casing. Such extendable wings may include brushes and/or scrapers. With the extendable wings located at the upper or lower end of the window, fluid flow through the well is again increased to a predetermined level such that the extendable wings are moved outwardly into contact with the parent casing. The cleanout tool is then rotated while it is moved up and down the window in order to remove cement, corrosion, or other debris from the interior of the parent casing. Upon successful cleaning of the window, the first cleanout tool is disabled and removed from the wellbore.

[0012] With the first cleanout tool disabled a second cleanout tool may be moved into position at the upper end of the window. Generally the second cleanout tool is a fluid jet cleanout tool where high-pressure fluid is forced radially outwards through circumferentially located ports. To actuate the fluid jet cleanout tool, generally a ball is dropped from the surface. The ball then descends through the tubular landing on a seat within the fluid jet cleanout tool. With the ball on the seat, the interior of the tubular is sealed. Pressure is increased within the tubular in order to apply force to retainers within the seat. The retainers may be sheer pins, retaining rings, or other devices requiring a preset force in order to release. Once the retainers release, the seat the seat moves downward exposing the circumferentially located ports within the tool so that the fluid with in the tubular is forced radially outward through the ports to clean the interior of the casing. With the seat open, and the fluid jet cleanout tool actuated, the assembly is rotated and lowered the length of the window to clean the interior of the parent casing. Upon reaching the lower end of the window, fluid ceases to be pumped downward from the surface and the tubular and assembly are removed from the well. While a ball actuated sleeve is described to actuate the fluid jet cleanout tool, other well known methods may be used to actuate the tool such as mud pulse, radio frequency identification tags, or other signaling to activate an electrically opened tool.

[0013] In some instances, it may be desirable to dispense with the multi-string cutter utilizing only the section mill. A multi-string cutter is generally any tool that, while able to remove tubular, such as casing or production casing or intermediate casing, longitudinally, i.e. as the tool moves downwards in the wellbore, the multi-string cutter is optimized to cut into and through the casing radially outwards. While the section mill is able to cut into the tubular radially outwards, such as when creating the initial window, the section mill is generally not as efficient at cutting radially into the production casing or intermediate casing but is generally optimized for cutting longitudinally.

[0014] While the system above describes rotating the assembly, it is important to note that the tubular and assembly may be rotated from the surface or a downhole power source able to provide rotational movement to the downhole assembly where the downhole power source is placed between the assembly and the tubular. For instance, in a case where coil tubing is used a mud motor may be placed at the lower end of the coil tubing and the cutting and cleanout assembly placed below the mud motor so that the mud motor may rotate the cleanout assembly without rotating the tubular above the assembly.

[0015] It has been envisioned that the cleanout system may be simplified even further such that the cleanout assembly may be limited to a lower centralizer a section mill or similar tool, and the fluid jet cleanout tool. In other instances the entire assembly or portions of the assembly may run without the preliminary cleanout tool.

[0016] In other instances it may be desirable to make two trips into the hole utilizing a centralizer and multi-string cutter for the first trip and a centralizer, section mill, and at least the fluid jet cleanout tool for the second trip.

[0017] Finally with the casing adjacent to the window clean and the cleanout assembly removed from the well, an operator may lower a plug into the window adjacent the casing. The packer may be a swellable plug, an inflatable plug, or any other device that will at least temporarily lock into position and seal the well. With the plug in place, and the setting tools removed from the well, a sufficient amount of cement may then be pumped into the well from the surface in order to plug the well.

[0018] An embodiment of the cleanout tool includes a centralizer, a cutting tool having an extendable cutter; and a fluid jetting tool. The wellbore cleanout tool may be rotated from the surface or may be rotated by a fluid driven downhole motor. The wellbore cleanout tool may also include a preliminary cutting tool having extendable cutters and the preliminary cutting tool may be a multi-string cutter. The cutting tool having an extendable cutter may be a section mill. The centralizer may be a taper mill.

[0019] A method of cleaning a wellbore includes running a cleanout assembly into a well wherein the cleanout assembly has a centralizer, a cutting tool, and a fluid jetting tool. Once located, a fluid flows through the cleanout assembly extending an extendable cutter from the cutting tool. The cutting tool with extended cutters then forms a window within a tubular by rotating and lowering the cutting tool. The fluid jetting tool is then actuated and the assembly is pulled out of the well. The cutting tool may be rotated from the surface or may be rotated by a fluid driven downhole motor. The method may further include the preliminary steps of running a preliminary cutter into the well, forming a preliminary window within the tubular; and pulling out of the well.

[0020] An alternative method of cleaning a wellbore include the steps of running a cleanout assembly into a well wherein the cleanout assembly has a centralizer, a cutting tool, a preliminary cleaning tool, and a fluid jetting tool. Flowing a fluid through the cleanout assembly. Extending an extendable cutter from the cutting tool. Extending a scraper from the preliminary cleaning tool. Forming a window within a casing by rotating and lowering the cutting tool. Actuating the fluid jetting tool and pulling out of the well. The cutting tool may be rotated from the surface or may be rotated by a fluid driven downhole motor.

[0021] The method may further include the preliminary steps of running a preliminary cutter into the well, forming a preliminary window within the tubular, and pulling out of the well.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a multi-string cutter, and a fluid jetting tool located therein.

[0023] FIG. **2** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a multi-string cutter, and a fluid jetting tool located therein where the multi-string cutter has cut a small window into the production casing or intermediate casing.

[0024] FIG. **3** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill, and a fluid jetting tool located adjacent a window in the production casing or intermediate casing.

[0025] FIG. **4** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill with the wings extended, and a fluid jetting tool located adjacent a window in the production casing or intermediate casing.

[0026] FIG. **5** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill with the wings extended, and a fluid jetting tool where the section mill is longitudinally extending the window in the production casing or intermediate casing.

[0027] FIG. **6** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill with the wings retracted, and a fluid jetting tool where the assembly has been raised into the lower stub of the production casing or intermediate casing and a ball is moving downward towards the seat within the fluid jetting tool.

[0028] FIG. **7** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill, and a fluid jetting tool where the seat within the fluid jetting tool has been lowered opening the ports, the fluid jetting tool lowered to the upper end of the window within the production casing or intermediate casing, and high-pressure fluid is being forced through the ports to clean the interior of the casing.

[0029] FIG. **8** depicts a production casing or intermediate casing cemented into a well further having a tapered mill, a section mill, and a fluid jetting tool where the fluid jetting tool has cleaned the interior of the casing to the lower end of the window within the production casing or intermediate casing.

[0030] FIG. **9** depicts a production casing or intermediate casing cemented into a well having a clean window adjacent the casing and a plug set within the window.

[0031] FIG. **10** depicts a production casing or intermediate casing cemented into a well having a plug set within the window in cement above the plug.

DETAILED DESCRIPTION

[0032] The description that follows includes exemplary apparatus, methods, techniques, or instruction sequences that embody techniques of the inventive subject matter. However, it is understood that the described embodiments may be practiced without these specific details.

[0033] FIG. **1** depicts a cleanout assembly **10** within the casing **12**. Within the casing **12**, production casing or intermediate casing **14** is attached to the casing **12** with a layer of cement **16**. The cement **16** is within the annular region **18** between the interior of the casing **12** and the exterior of the production casing or intermediate casing **14**. The cleanout assembly **10** is attached to the lower end of the tubular **20**. Tubular **20** may be a work over string, a drill string, coil tubing, or other tubular. The cleanout assembly **10** has at its lower end a taper mill **22**. The taper mill **22** centralizes the cleanout assembly **10** within the production tubular **14**. Additionally the taper mill **22** may be utilized to remove obstructions within the production tubular **14** as the cleanout assembly **10** is lowered into the production tubular **14**. Above the taper mill **22** is multi-string cutter **24**. Multi-string cutter **24** has circumferentially spaced about its body extendable wings **26**. In the run-in configuration depicted the extendable wings **26** are retracted into the body **28** of the multi-string cutter **24**. The multi-string cutter **24** is generally useful for cutting radially outward into a tubular, such as production casing or intermediate casing **14**. The extendable wings **26** are optimized for, but not limited to, cutting radially outward. In the configuration of the cleanout assembly **10** a fluid jetting tool **30** is located above multi-string cutter **24**. The sleeve **32** is depicted in the closed position preventing any fluid in the interior **34** of the tubular **20** from passing from the interior **34** of the tubular **20** to the exterior **36** of tubular **20** through port **38** shear pins, such as shear pin **40** prevents the sleeve **32** from opening prematurely.

[0034] FIG. **2** depicts the cleanout assembly **10** from FIG. **1** located at the desired position within production tubular **14**. The taper mill **22** keeps the cleanout assembly **10** centralized while fluid flow through the interior **34** of the production tubular **14** flows downward as indicated by arrow **42**. The fluid flow is at a predetermined rate through the multi-string cutter **24** in order to extend radially outward the extendable wings **26** such that the outer tip **27** of the extendable wings **26** extend into and as they cut will extend radially past production casing or intermediate casing **14**. With the wings **26** extended radially outward cleanout assembly **10** is rotated causing a circumferential cut into production casing or intermediate casing **14** as way to sit down upon the tubular **20** the multi-string cutter **24** cut a small window **44** into the production tubular **14**.

[0035] FIG. **3** depicts a second cleanout tool **50** located within the production tubular **14** as depicted in FIGS. **1** and **2**. In FIG. **3** the multi-string cutter **24** from FIGS. **1** and **2** has been replaced by section mill **52**. Section mill **52** has extendable wings **54** which in this instance are located adjacent to window **44**. The section mill **52** extendable wings **54** are depicted in the recessed or run-in position. The cleanout tool **50** has taper mill **22** to maintain the cleanout tool **50** centralized within the production casing or intermediate casing **14**. It is envisioned that the taper mill **22** could be replaced by a rigid or other centralizer.

[0036] FIG. **4** depicts the cleanout assembly **50** from FIG. **3** located at the desired position, with extendable wings **54** of section mill **52** adjacent to window **44**, within production tubular **14**. As the taper mill **22** maintains the cleanout assembly **50** in a centralized position within the production tubular, fluid flow through the interior **34** of the production tubular **14** flows downward as indicated by arrow **42**. As with the multi-string cutter **24** fluid flows at a predetermined rate through the section mill **52** causing extendable wings **54** to extend radially outward such that the outer edge **56** of the extendable wings **54** extend radially past production casing or intermediate casing **14**. With the wings **54** extended radially outward, cleanout assembly **50** is rotated while weight is applied by lowering tubular **20** from the surface causing the extendable wings **54** to longitudinally cut into production casing or intermediate casing **14** thereby extending the length of the window **44** in the production tubular **14**. The cleanout assembly **50** may be rotated from the surface through tubular **20** via a rigid connection to cleanout assembly **50**. In other instances the tubular **20** may be held rigidly against rotation at the surface while a mud motor or other fluid driven device that will impart sufficient torque rotates the cleanout assembly **50**.

[0037] FIG. **5** depicts the cleanout assembly **50** from FIG. **4** located at the lower end **58** of the now extended window

44 within production tubular **14**. Generally the portion of production tubular **44** above window **44** is referred to as the upper stub **60** while the portion of the production tubular **44** below window **44** is referred to as the lower stub **62**. With window **44** now extended to the desired length fluid flow through the interior **34** of tubular **20** is stopped.

[0038] FIG. **6** depicts cleanout assembly **50** with cleanout assembly **50** moved upward within upper stub **60** of production casing or intermediate casing **14**. It is preferable to move cleanout assembly **50** into upper stub **60** so that at least extendable wings **54** are within upper stub **60**. Having at least extendable wings **54** of section mill **52** within upper stub **60** it is insured that the fluid flow in the direction of arrow **64** through tubular **20** required to move the ball **66** to seat **32** will not cause extendable wings **54** to extend past the inner surface **70** of production casing or intermediate casing **14**. It is preferable that extendable wings **54** do not extend past the diameter of the inner surface **70** of production casing or intermediate casing **14**. By having the extendable wings **54** within the diameter of the inner surface **70** of production casing or intermediate casing **14** the taper mill or centralizer **22** is able to prevent the extendable wings **54** from contacting casing **12**.

[0039] FIG. **7** shows the cleanout tool **50** lowered into position so that the ports **40** of fluid jetting tool **30** extend below the lower end of upper stub **60** adjacent the upper end of window **44**. The ball **66** has landed on seat **32** and fluid flow in the direction of arrow **64** through the interior **34** of tubular **20** and fluid jetting tool **30** has caused the shear pins **32** to shear. With the shear pins removed the sleeve **32** is released to move downward thereby allowing fluid flow from the interior **34** through ports **40**. The high pressure fluid impacts the cement **16** that remains in the now exposed annular area **18** of window **44** dislodging the remaining cement and other debris.

[0040] In certain instances located below fluid jetting tool **30** is a preliminary cleaning tool **80**. Preliminary cleaning tool **80** has extendable wings **82**. Fluid flow in the direction indicated by arrow **64** through the interior **34** of tubular **20** causes extendable wings **82** to extend outward such that the outer edge **86** of extendable wings **82** contacts the inner surface **71** of casing **12**. Generally the extendable wings **82** may be brushes or scrapers where the scraper is rigid enough to remove cemented or debris but does not have a cutting edge that might damage the inner surface **71** of casing **12**. In many instances preliminary cleaning tool **80** may be omitted from cleanout tool **50**.

[0041] FIG. **8** depicts the ports **40** a fluid jetting tool **30** adjacent the upper end of lower stub **62** after the fluid jetting tool **30** has been rotated and lowered between upper stub **60** and lower stub **62** where the cement **16** as well as any corrosion or debris within window **44** has been removed leaving the interior surface **71** of casing **12** and a condition suitable to be sealed with a plug.

[0042] FIG. **9** depicts plug **90** on the lower end of tubular **20** located within window **44** at the upper end of stub **62**. The plug **90** has been set such that plug **90** seals against inner surface **71** of casing **12** preventing fluid flow past the plug.

[0043] FIG. **10** depicts plug **90** seated against inner casing surface **71** within window **44** above stub **62** cement **100** has been placed above plug **90** to form a permanent plug within casing **12**.

[0044] While the embodiments are described with reference to various implementations and exploitations, it will be understood that these embodiments are illustrative and that the scope of the inventive subject matter is not limited to them. Many variations, modifications, additions and improvements are possible.

[0045] Plural instances may be provided for components, operations or structures described herein as a single instance. In general, structures and functionality presented as separate components in the exemplary configurations may be implemented as a combined structure or component. Similarly, structures and functionality presented as a single component may be implemented as separate components. These and other variations, modifications, additions, and improvements may fall within the scope of the inventive subject matter.

What is claimed is:

1. A wellbore cleanout tool comprising:
a centralizer;
a cutting tool having an extendable cutter; and
a fluid jetting tool.

2. The wellbore cleanout tool of claim **1** wherein, the wellbore cleanout tool is rotated from the surface.

3. The wellbore cleanout tool of claim **1** wherein, the wellbore cleanout tool is rotated by a fluid driven downhole motor.

4. The wellbore cleanout tool of claim **1** further comprising: a preliminary cutting tool having extendable cutters.

5. The wellbore cleanout tool of claim **4** wherein, the preliminary cutting tool is a multi-string cutter.

6. The wellbore cleanout tool of claim **1** wherein, the cutting tool having an extendable cutter is a section mill.

7. The wellbore cleanout tool of claim **1** wherein, the centralizer is a taper mill.

8. A method of cleaning a wellbore comprising:
running a cleanout assembly into a well;
wherein the cleanout assembly has a centralizer, a cutting tool, and a fluid jetting tool;
flowing a fluid through the cleanout assembly;
extending an extendable cutter from the cutting tool;
forming a window within a tubular by rotating and lowering the cutting tool;
actuating the fluid jetting tool; and
pulling out of the well.

9. The method of cleaning a wellbore of claim **8** wherein the cutting tool is rotated from the surface.

10. The method of cleaning a wellbore of claim **8** wherein the cutting tool is rotated by a fluid driven downhole motor.

11. The method of cleaning a wellbore of claim **8** further comprising the preliminary steps:
running a preliminary cutter into the well;
forming a preliminary window within the tubular; and
pulling out of the well.

12. A method of cleaning a wellbore comprising:
running a cleanout assembly into a well;
wherein the cleanout assembly has a centralizer, a cutting tool, a preliminary cleaning tool, and a fluid jetting tool;
flowing a fluid through the cleanout assembly;
extending an extendable cutter from the cutting tool;
extending a scraper from the preliminary cleaning tool;
forming a window within a casing by rotating and lowering the cutting tool;
actuating the fluid jetting tool; and
pulling out of the well.

13. The method of cleaning a wellbore of claim **12** wherein the cutting tool is rotated from the surface.

14. The method of cleaning a wellbore of claim **12** wherein the cutting tool is rotated by a fluid driven downhole motor.

15. The method of cleaning a wellbore of claim **12** further comprising the preliminary steps:

running a preliminary cutter into the well;

forming a preliminary window within the tubular; and

pulling out of the well.

* * * * *