US 20170044864A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2017/0044864 A1

(43) Pub. Date: Feb. 16, 2017

SABINS et al.

(54) **METHOD OF SEALING WELLS BY SQUEEZING SEALANT**

(71) Applicant: **CSI Technologies LLC**, Houston, TX (US)

(72) Inventors: **Fred SABINS**, Montgomery, TX (US); **Clifton MEADE**, Houston, TX (US); **David BROWN**, Cypress, TX (US); **Jeffrey WATTERS**, Spring, TX (US); **Jorge Esteban LEAL**, Houston, TX (US)

(21) Appl. No.: **15/185,334**

(22) Filed: **Jun. 17, 2016**

Related U.S. Application Data

(60) Provisional application No. 62/203,140, filed on Aug. 10, 2015.

Publication Classification

(51) **Int. Cl.**

E21B 33/14 (2006.01)

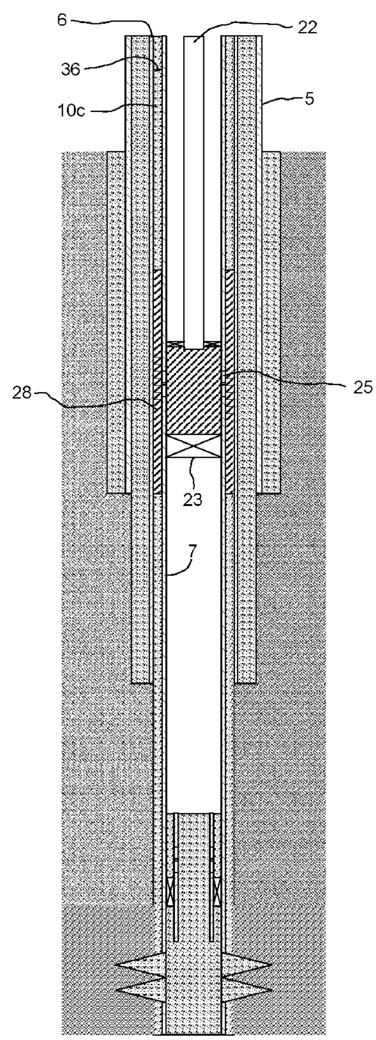
E21B 33/12 (2006.01)

(52) **U.S. Cl.**

CPC *E21B 33/14* (2013.01); *E21B 33/12* (2013.01)

(57) **ABSTRACT**

A method for sealing a well includes: placing an obstruction in a bore of an inner tubular string disposed in a wellbore; forming an opening through a wall of the inner tubular string above the obstruction; mixing a resin and a hardener to form a sealant; and squeezing the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and an outer tubular string, thereby repairing a cement sheath present in the annulus.



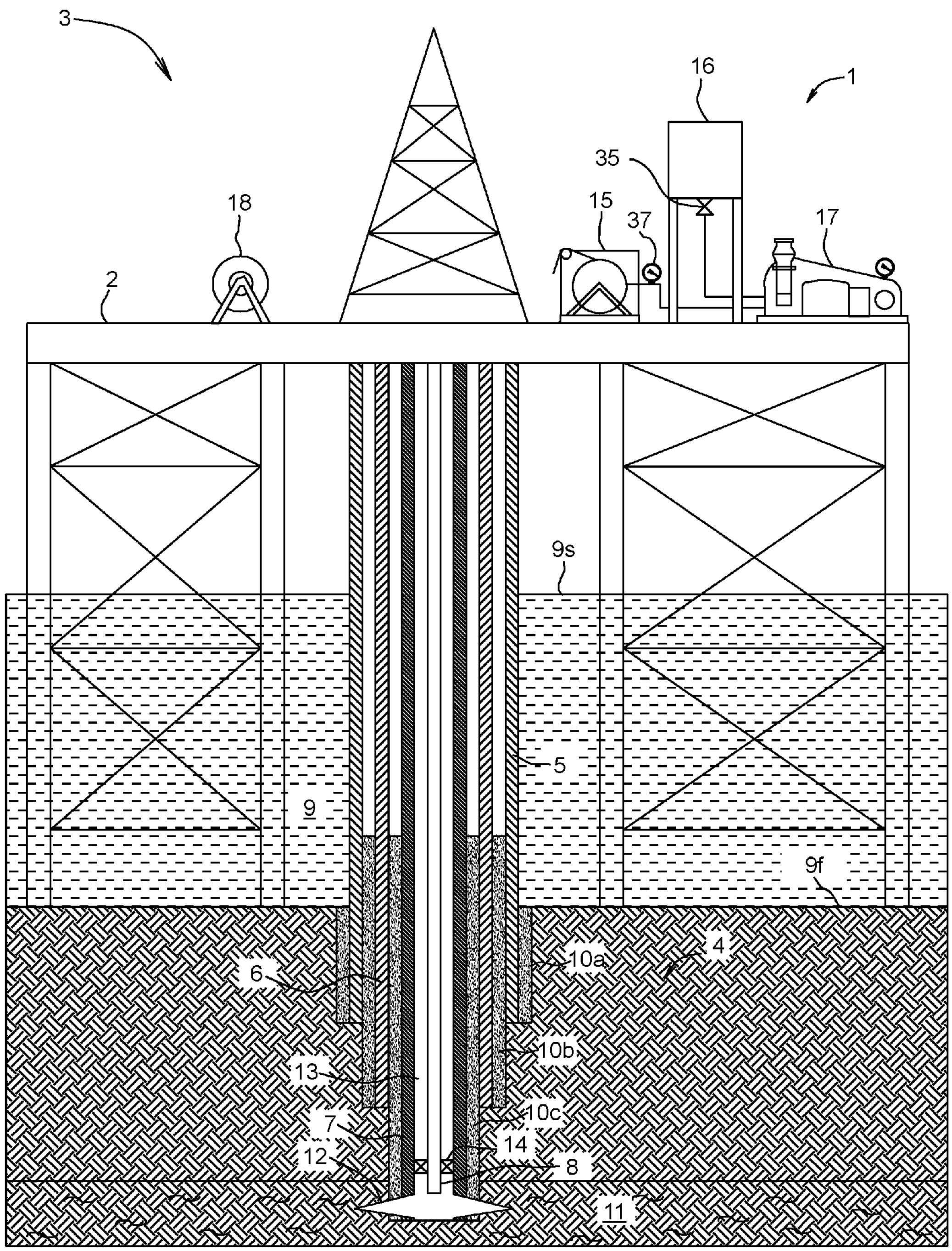


FIG. 1

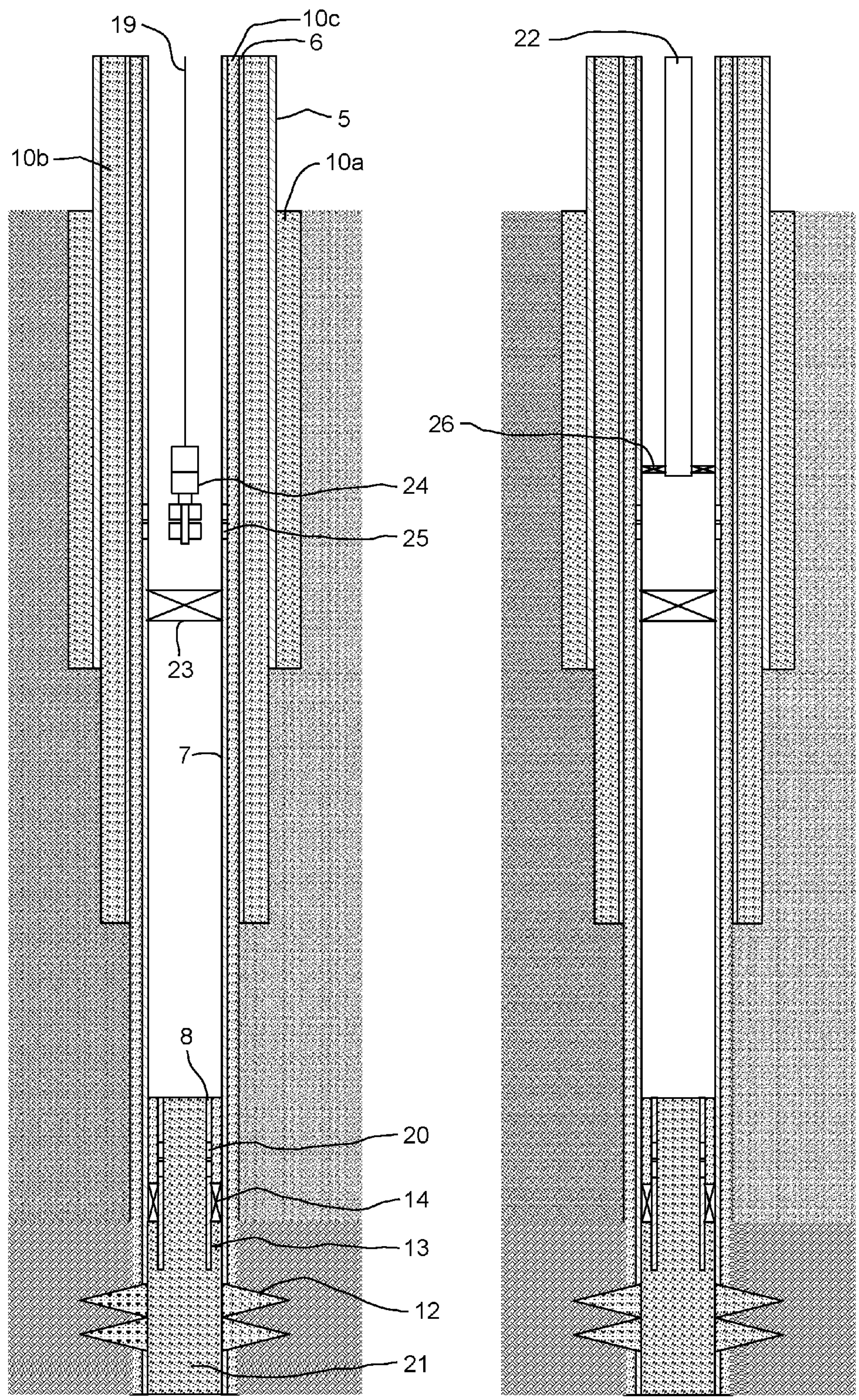


FIG. 2A

FIG. 2B

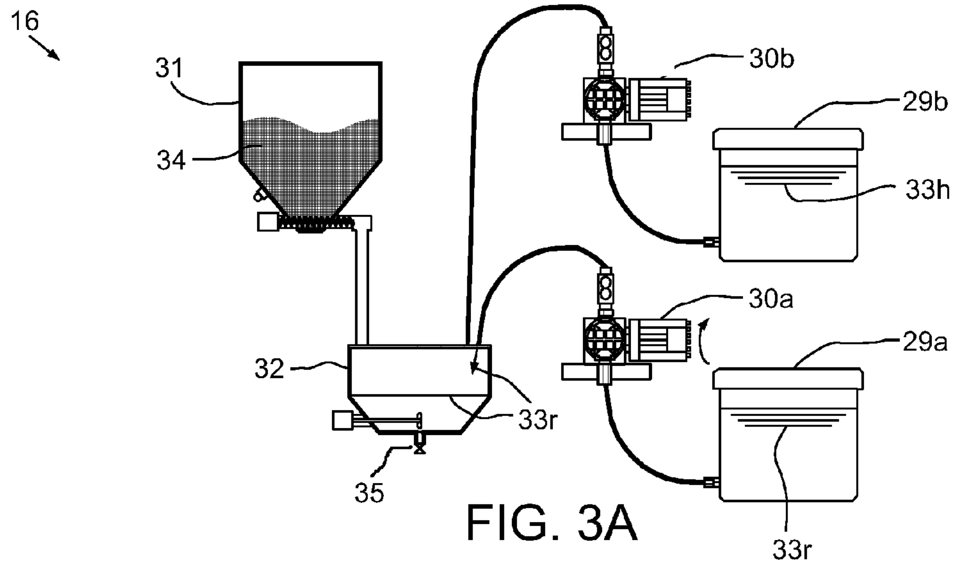


FIG. 3A

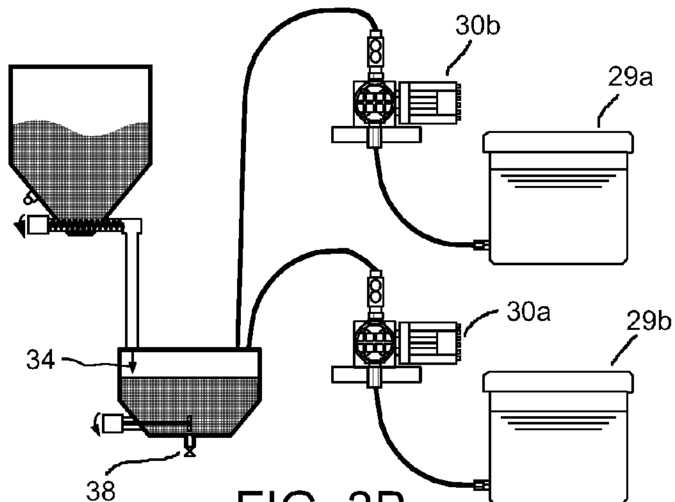


FIG. 3B

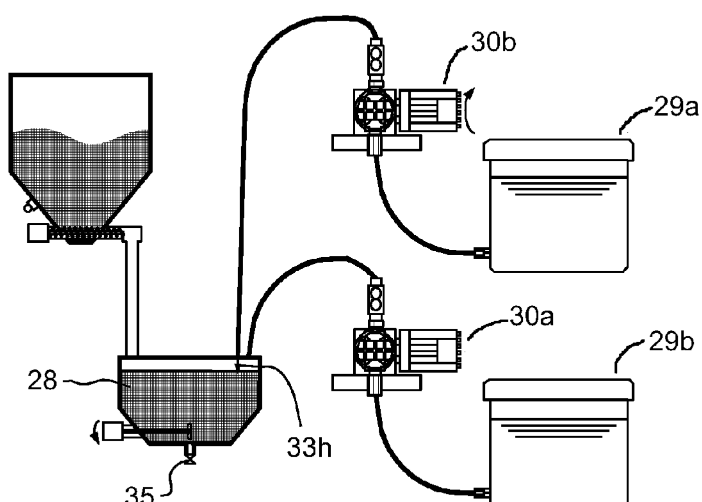


FIG. 3C

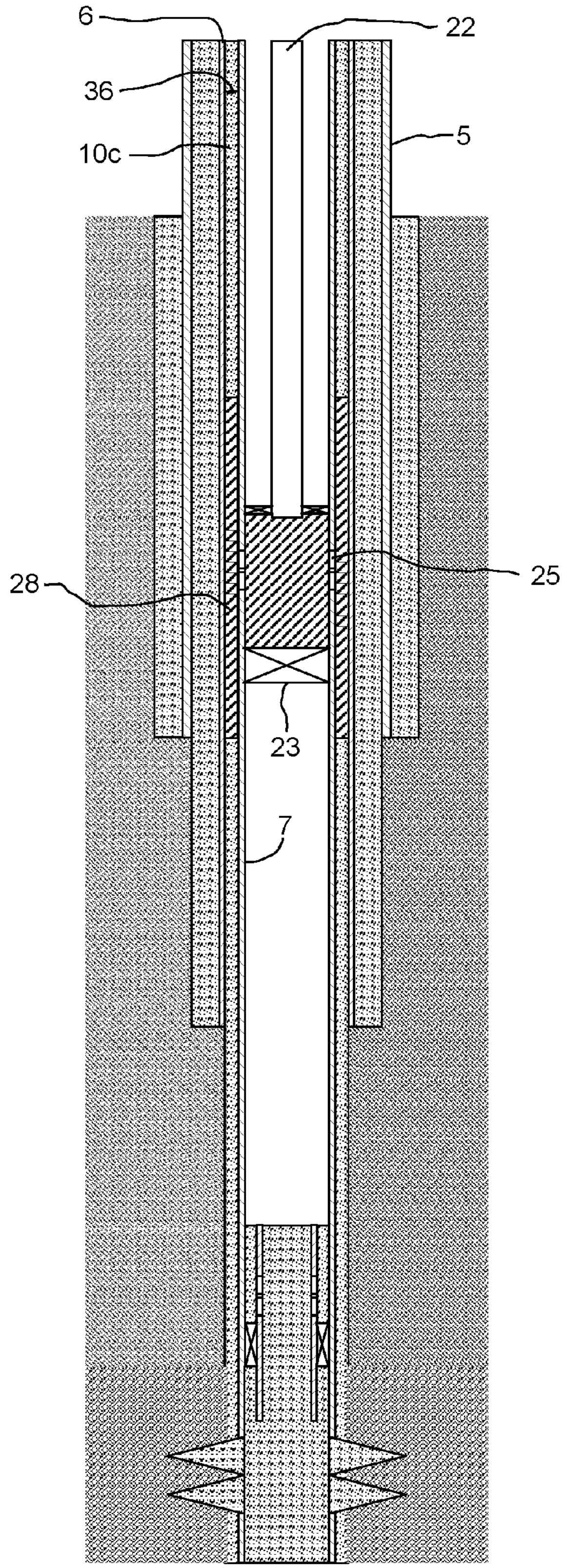


FIG. 4

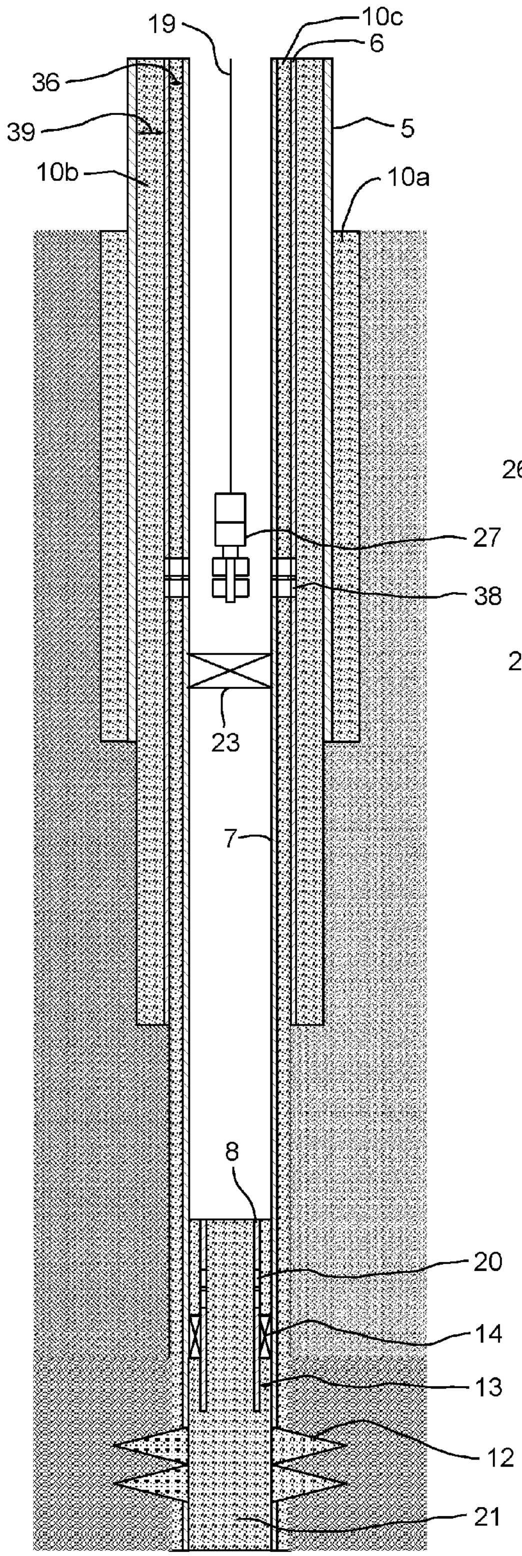


FIG. 5A

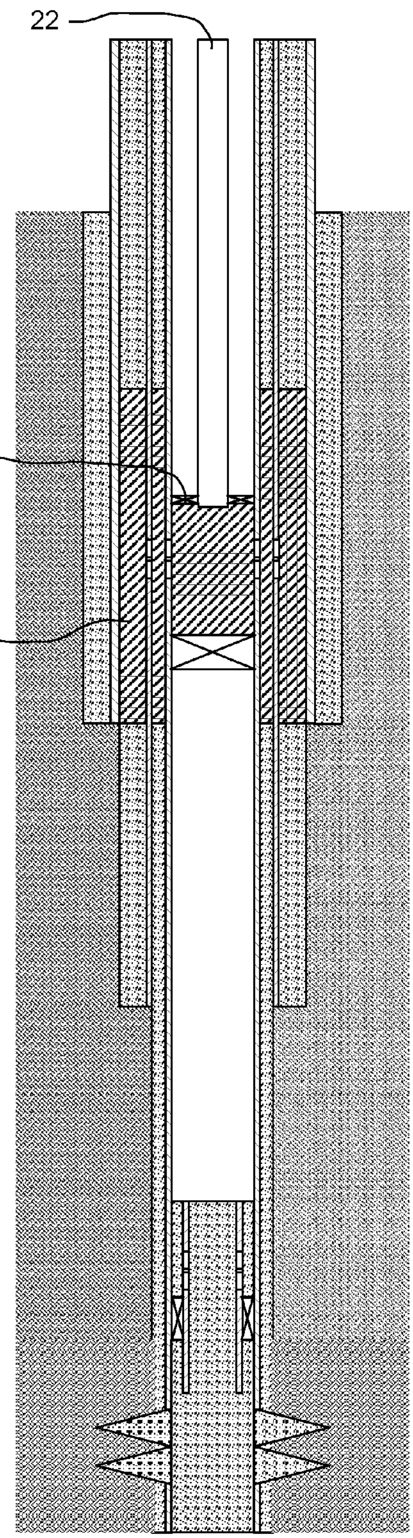


FIG. 5B

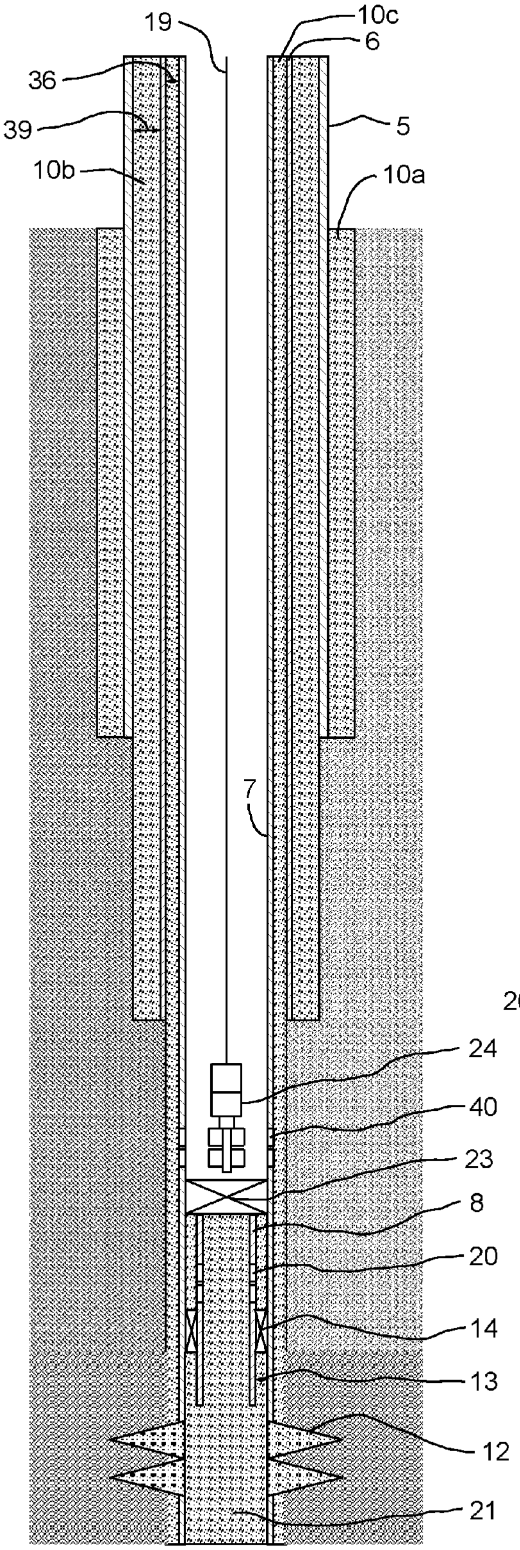


FIG. 6A

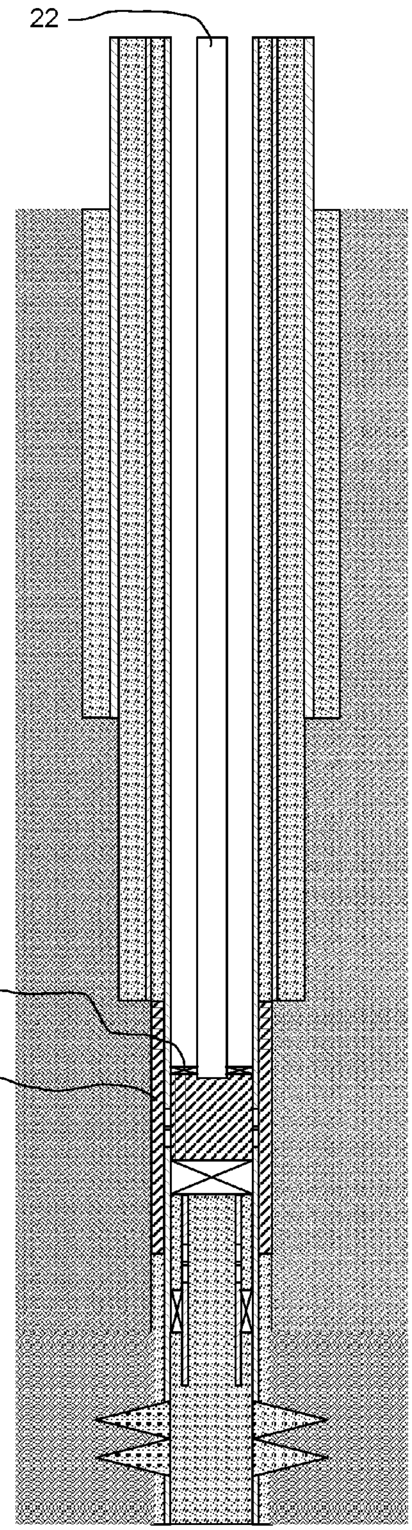


FIG. 6B

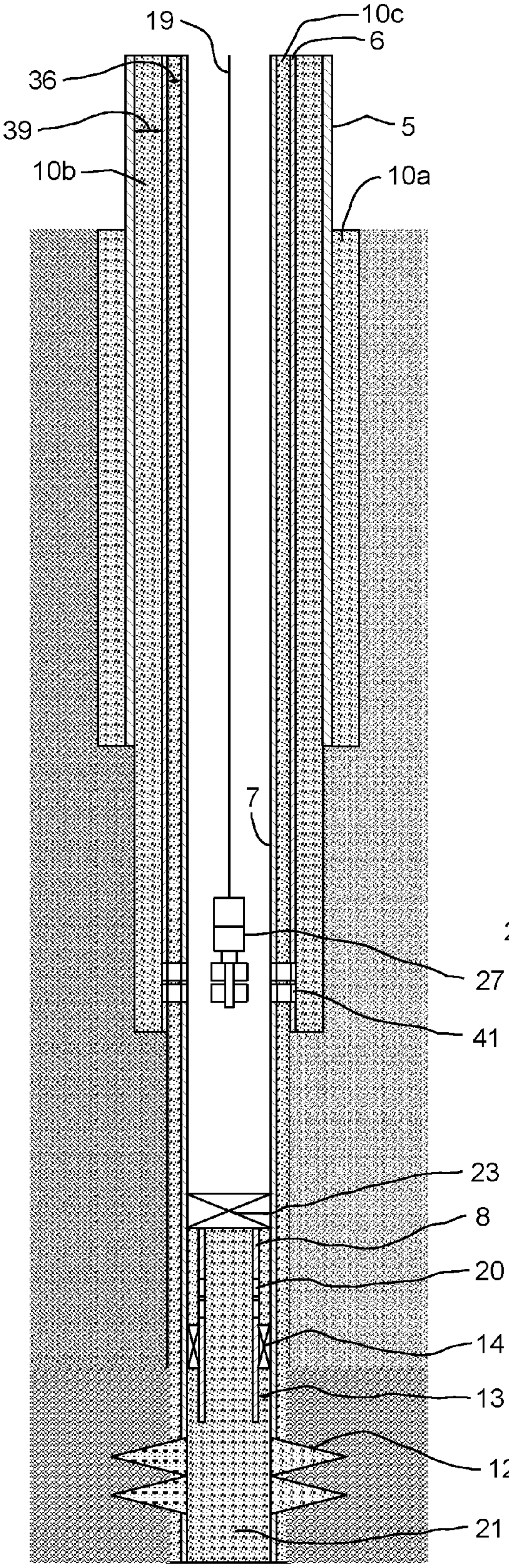


FIG. 7A

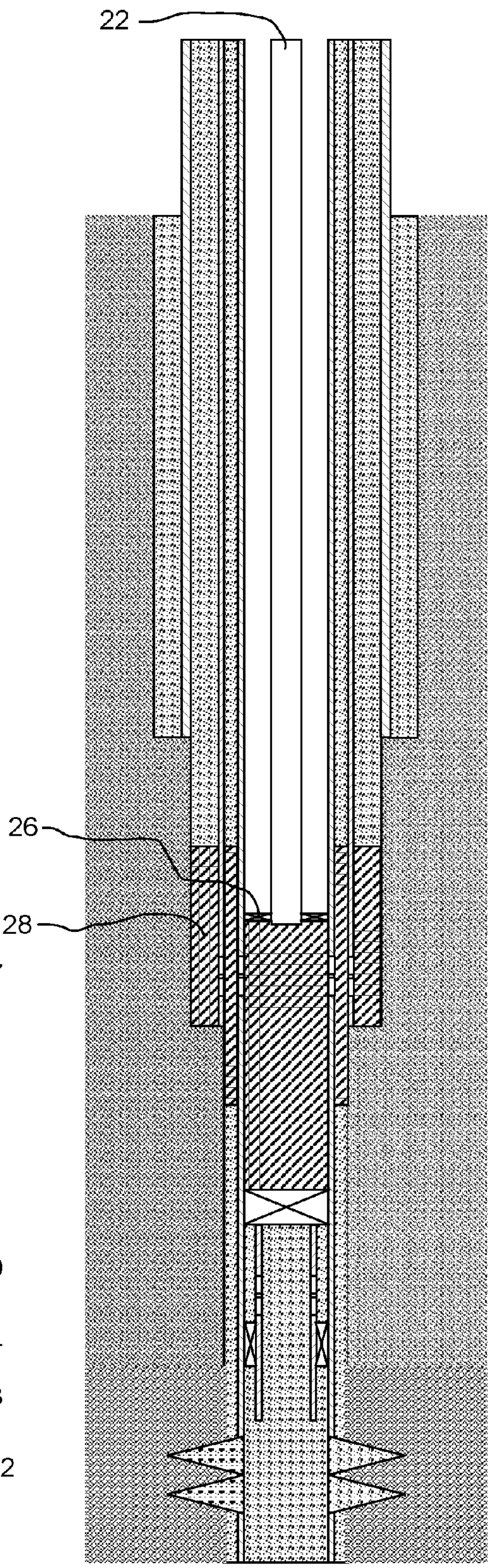


FIG. 7B

METHOD OF SEALING WELLS BY SQUEEZING SEALANT

BACKGROUND OF THE DISCLOSURE

[0001] Field of the Disclosure

[0002] The present disclosure generally relates to a method of sealing wells by squeezing a sealant into an annulus thereof.

[0003] Description of the Related Art

[0004] The hard impermeable sheath deposited in the annular space in a well by primary cementing is subjected to a number of stresses during the lifetime of the well. The pressure inside the casing can increase or decrease as the fluid filling it changes or as additional pressure is applied to the well, such as when the drilling fluid is replaced by a completion fluid or by a fluid used in a stimulation operation. A change of temperature also creates stress in the cement sheath, at least during the transition period before the temperatures of the steel and the cement come into equilibrium. As a result of pressure and temperature changes, the integrity of the cement sheath can be compromised. Thus, it can become necessary to repair the primary cement sheath, such as during a plug and abandonment operation. One way to repair the primary cement sheath is by squeeze cementing, i.e., squeezing Portland cement thereinto.

[0005] The use of conventional Portland cement for squeeze cementing has limitations, for instance, if the primary cement sheath is leaking fluid, such as gas, through micro-channels, squeeze cementing is not feasible, even using micro-fine ground Portland cement.

SUMMARY OF THE DISCLOSURE

[0006] The present disclosure generally relates to a method of sealing wells by squeezing sealant into the annulus between the inner and outer tubular strings. In one embodiment, a method for sealing a well includes: placing an obstruction in a bore of an inner tubular string disposed in a wellbore; forming an opening through a wall of the inner tubular string above the obstruction; mixing a resin and a hardener to form a sealant; and squeezing the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and an outer tubular string, thereby repairing a cement sheath present in the annulus.

[0007] In another embodiment, a method for sealing a well includes: placing an obstruction in a bore of an inner tubular string disposed in a wellbore; forming an opening through a wall of the inner tubular string above the obstruction; mixing a resin and a hardener to form a sealant; and squeezing the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and the wellbore, thereby repairing a cement sheath present in the annulus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this disclosure and are therefore not to be considered limiting of its scope, for the disclosure may admit to other equally effective embodiments.

[0009] FIG. **1** illustrates delivery of an equipment package to a platform for performing the squeeze operation, according to one embodiment of the present disclosure.

[0010] FIG. **2**A illustrates perforation of a production casing string. FIG. **2**B illustrates deployment of a sealing string.

[0011] FIGS. **3**A-**3**C illustrate operation of a mixing unit of the equipment package to form sealant.

[0012] FIG. **4** illustrates squeezing of the sealant into an annulus formed between the production casing string and a surface casing string.

[0013] FIGS. **5**A and **5**B illustrate a first alternative sealing operation, according to another embodiment of the present disclosure.

[0014] FIGS. **6**A and **6**B illustrate a second alternative sealing operation, according to another embodiment of the present disclosure.

[0015] FIGS. **7**A and **7**B illustrate a third alternative sealing operation, according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0016] FIG. **1** illustrates an illustrative equipment package **1** used for performing the squeeze operation, and located on a platform **2**, according to one embodiment of the present disclosure. The platform **2** may be part of a well **3** further including a subsea wellbore **4**, a drive pipe **5**, a surface casing string **6**, a production casing string **7**, and a production tubing string **8**. The drive pipe **5** is commonly set from above a surface **9***s* (aka waterline) of the sea **9**, through the sea, and into the seafloor **9***f* (aka mudline). The drive pipe **5** allows the wellhead (not shown) to be located on the platform **2** above the waterline **9***s*.

[0017] Once the drive pipe **5** has been set, and (if desired cemented **10***a*, the subsea wellbore **4** is drilled into the seafloor **9***f* within the envelope of the drive pipe **5**. The surface casing string **6** is then run-in the drive pipe **5** and into the wellbore **4** and cemented into place by forming a cement sheath **10***b*. When the wellbore **4** reaches a hydrocarbon-bearing formation **11**, i.e., crude oil and/or natural gas, the production casing **7** is run-into the wellbore **4** and cemented into place with cement sheath **10***c*. Thereafter, the production casing string **7** is perforated **12** to permit the fluid hydrocarbons (not shown) to flow into the interior thereof. The hydrocarbons are transported from the formation **11** through the production tubing string **8**. An annulus **13** defined between the production casing string **7** and the production tubing string **8** is commonly isolated from the producing formation **11** with a production packer **14**.

[0018] During production of hydrocarbons from the well **3**, it may become necessary to workover the well, install an artificial lift system, and/or stimulate or treat the formation **11**. To facilitate any of these operations, it is typically desirable to temporarily plug the well **3**. Also, once the formation **11** has been produced to depletion, regulations often require permanently plugging the well **3** prior to abandoning the well **3**. If either or both of the cement sheathes **10***b,c* have become compromised, they will need to be repaired during either the temporary or permanent plugging and abandonment operation, using the squeeze operation.

[0019] In order to prepare for the squeeze operation, the equipment package **1** is delivered to the platform **2** via a transport vessel (not shown). The equipment package includes a coiled tubing unit **15**, a mixing unit **16**, and a squeeze pump **17**. The coiled tubing unit **15** includes a drum having coiled tubing **22** (FIG. **2**B) wrapped therearound, a gooseneck, an injector head for driving the coiled tubing, controls, and a hydraulic power unit. A wireline winch **18** onboard the platform **2** may also be used to facilitate the squeeze operation. The wireline winch **18** typically includes a drum having wireline **19** (FIG. **2**A) wrapped therearound and a motor for winding and unwinding the wireline, thereby raising and lowering a distal end of the wireline relative to the platform **2**.

[0020] FIG. **2**A illustrates perforation of the production casing string **7**. FIG. **2**A shows the condition of the well during an abandonment or closing in operation, wherein a lower cement plug **21** has been set and the production tubing string **8** has been cut. To establish this condition, the well **3** abandonment operation commences by connecting a bottomhole assembly (BHA) (not shown) to the wireline **19** extending through a lubricator (not shown). In the embodiment, the BHA includes a cablehead, a collar locator, and a tubing perforator, such as a perforating gun.

[0021] To deploy the BHA into the well bore, one or more valves of the tree are opened and the BHA is deployed into the production tubing string in the wellbore **4** using the wireline **19**. The BHA is deployed to a depth adjacent to and above the production packer **14**. Once the BHA has been deployed to the desired depth, electrical power or an electrical signal is supplied to the BHA via the wireline **19** to fire the perforating gun into the production tubing string **8**, thereby forming tubing perforations **20** through the wall thereof. The BHA is retrieved to the lubricator and the lubricator is then removed from the production tree.

[0022] Cement slurry (not shown) is then pumped through the production tree head, down the production tubing string **8**, and into the annulus **13** via the created tubing perforations **20**. Wellbore fluid displaced by the cement slurry will flow up the annulus **13**, through the wellhead and to the platform **2**. Once a desired quantity of cement slurry has been pumped into the annulus **13**, an annulus valve of the wellhead is closed while continuing to pump the cement slurry, thereby forcing or "squeezing" cement slurry into the adjacent formation **11**. Once pumped into place, the cement slurry is allowed to cure for a predetermined amount of time, such as one hour, six hours, twelve hours, or one day, thereby forming the cement plug **21** in the annulus, the surrounding formation, and within the lower portion of the production tubing string **8**.

[0023] Once the cement plug **21** has cured, a second BHA (not shown) is connected to the wireline **19** in the lubricator and deployed through the production tree. The second BHA commonly includes a cablehead, a collar locator, an anchor, a hydraulic power unit (HPU), an electric motor, and a tubing cutter. The second BHA is deployed into the production tubing string **8** to a depth adjacent to and above the production packer **14**. Once the second BHA has been deployed to the cutting depth, the HPU is operated by supplying electrical power via the wireline **19** to extend blades of the tubing cutter and operate the motor to rotate the extended blades, thereby severing an upper portion of the production tubing string **8** from a lower portion thereof. The second BHA is then retrieved to the lubricator and the lubricator is removed from the production tree. The production tree is removed from the wellhead and the severed upper portion of the production tubing string **8** is removed from the wellbore **4**, leaving the wellbore in the state shown in FIG. **2**A.

[0024] Once the severed portion of the production tubing string **8** has been removed, a third BHA (not shown) is connected to the wireline **19** in the lubricator and deployed through the wellhead. The third BHA commonly includes a cablehead, a collar locator, a setting tool, and a bridge plug **23**. The third BHA is deployed to a setting depth along a portion of the production casing string **7** adjacent, and above, the lower terminus of the surface casing string **6**. Once the third BHA has been deployed to the setting depth, electrical power is supplied to the third BHA via the wireline **19** to operate the setting tool, thereby expanding the bridge plug **23** against an inner surface of the production casing string **7**. Once the bridge plug **23** has been set as shown in FIG. **2**A, the bridge plug **23** is released from the setting tool. The third BHA (minus the bridge plug **23**) is then retrieved to the lubricator and the lubricator is removed from the wellhead.

[0025] A fourth BHA **24** is then connected to the wireline **19** in the lubricator and deployed through the wellhead. The fourth BHA **24** commonly includes a cablehead, a collar locator, and a casing perforator, such as a perforating gun. The fourth BHA **24** is deployed to a firing depth adjacent to and above the bridge plug **23**. Once the fourth BHA **24** has been deployed to the firing depth, electrical power or an electrical signal is supplied to the fourth BHA via the wireline **19** to fire the perforating gun into the production casing string **7**, thereby forming casing perforations **25** through a wall thereof as shown in FIG. **2**A. The fourth BHA **24** is then retrieved to the lubricator and the lubricator is removed from the wellhead.

[0026] FIG. **2**B illustrates deployment of a sealing string. A fifth BHA **26** is connected to the coiled tubing **22** in a snubbing unit (not shown) and deployed through the wellhead. The fifth BHA **26** includes a squeeze packer and a setting tool. The injector head of the coiled tubing unit **15** is operated to lower the fifth BHA **26** to a squeezing depth adjacent to and above the casing perforations **25**. Once the fifth BHA **26** has been deployed to the squeezing depth, the squeeze pump **17** is operated to pump a setting plug (not shown), such as a ball, through the coiled tubing **22** to a seat of the setting tool. Fluid pressure may then be exerted on the seated ball to operate the setting tool, thereby expanding the squeeze packer against an inner surface of the production casing string **7** to thereby seal the annuals between the coiled tubing **22** and the production casing string **7**. In the embodiment, additional fluid pressure is then applied to drive the ball through the seat of the setting tool, thereby reopening the bore of the coiled tubing **22**.

[0027] FIGS. **3**A-**3**C illustrate operation of the mixing unit **16** to form sealant **28**. The mixing unit **16** in the embodiment includes two or more liquid totes **29***a,b*, and a transfer pump **30***a, b* for each liquid tote, a dispensing hopper **31**, and a blender **32**.

[0028] Each transfer pump **30***a,b* is, in the embodiment, a metering pump and the dispensing hopper **31** is a metering hopper. An inlet of each transfer pump **30***a,b* is connected to a respective liquid tote **29***a,b*.

[0029] A first liquid tote **29***a* of the liquid totes **29***a,b* includes a resin **33***r*. The resin **33***r* may be an epoxide, such as bisphenol F. The viscosity of the sealant **28** may be adjusted by premixing the resin **33***r* with a diluent, such as alkyl glycidyl ether or benzyl alcohol. The viscosity of the sealant **28** may range between fifty and two thousand centipoise. The epoxide may also be premixed with a bonding agent, such as silane. A second liquid tote **29***b* of the liquid totes **29***a,b* may include a hardener **33***h* selected based on the temperature in the wellbore **4**. The contents of the liquid totes **29***a,* b may be reversed. For low temperature applications, the hardener **33***h* may be an aliphatic amine or polyamine or a cycloaliphatic amine or polyamine, such as tetraethylenepentamine. For high temperature applications, the hardener **33***h* may be an aromatic amine or polyamine, such as diethyltoluenediamine. The dispensing hopper **31** includes a particulate weighting material **34** having a specific gravity of at least two. The weighting material **34** may be barite, hematite, hausmannite ore, or sand.

[0030] Alternatively, wellbore fluid may be non-aqueous and the resin **33***r* may also be premixed with a surfactant to maintain cohesion thereof. Alternatively, the resin **33***r* may also be premixed with a defoamer.

[0031] To form the sealant **28**, the first transfer pump **30***a* is operated to dispense the resin **33***r* into the blender **32**. A motor of the blender **32** is then activated to churn the resin **33***r*. The hopper **31** is then operated to dispense the weighting material **34** into the blender **32**. The weighting material **34** is added, as required, in a proportionate quantity such that a density of the sealant **28** corresponds to a density of the wellbore fluid. The density of the sealant **28** may be equal to, slightly greater than, or slightly less than the density of the wellbore fluid.

[0032] The second transfer pump **30***b* is operated to dispense the hardener **33***h* into the blender **32**. The hardener **33***h* is added in a proportionate quantity such that the thickening time of the sealant **28** corresponds to the time required to pump the sealant through the coiled tubing **22**, plus the time required to squeeze the sealant into the annulus **36** (FIG. **4**) formed between the production casing string **7** and the surface casing string **6**, plus a safety factor, such as one hour. Once the blender **32** has formed the components of the sealant **28** into a homogenous mixture, a supply valve **35** connecting the outlet of the blender ultimately to the squeeze pump **17** may be opened.

[0033] FIG. **4** illustrates squeezing of the sealant **28** into the annulus **36**. The squeeze pump **17** is operated to pump the sealant **28** from the blender **32** and into the coiled tubing **22**. The pumping may be monitored using the pressure gauge **37** of the equipment package **1**. Once the sealant **28** has been pumped into the coiled tubing **22** downstream of the squeeze pump **17**, the inlet of the squeeze pump **17** is then connected to a supply of chaser fluid (not shown), such as seawater, and the squeeze pump **17** is operated to pump the chaser fluid into the coiled tubing **22**, thereby driving the sealant **28** through the coiled tubing **22** and into the annulus **36** via the casing perforations **25**. The sealant **28** flows into or through voids in the cement sheath **10***c* present in the annulus **36**, thereby filling the voids and restoring the integrity of the cement sheath **10***c*. As the stroke volume of the squeeze pump may be known or calculated, a stroke counter of the squeeze pump **17** may be monitored during pumping and the squeeze pump shutoff once a desired volume of the chaser fluid has been pumped based on a certain number of strokes, corresponding to the internal volume of the coiled tubing **22** extending from the squeeze pump **17**, thereby ensuring that all of the sealant **28** has been discharged from the coiled tubing **22**. A portion of the sealant **28** also typically forms a bore plug in the production casing string **7**. The sealant **28** may also plug a portion of the cement sheath **10***c* adjacent to the surface casing string **6**.

[0034] The squeeze packer is then unset, such as by exerting tension on (pulling on) the coiled tubing **22**. The coiled tubing **22** and the fifth BHA **26** is retrieved to the platform **2** and the sealant is allowed to cure for a time, such as between one to five days. If the abandonment operation is permanent, once the sealant **28** has cured, the drive pipe **5**, surface casing string **6**, and production casing string **7** will typically be cut at or just below the seafloor **9***f,* thereby completing the abandonment operation.

[0035] FIGS. **5**A and **5**B illustrate a first alternative sealing operation, according to another embodiment of the present disclosure. In this alternative method of sealing, a sixth BHA **27** is deployed instead of the fourth BHA **24**. The sixth BHA **27** is deployed to the firing depth adjacent to and above the bridge plug **23**. The sixth BHA **27** is similar to the fourth BHA **24** except for having a deep casing perforator, such as a perforating gun, instead of the casing perforator. The deep casing perforating gun has a charge strength sufficient to form deep perforations **38** through the walls of the production **7** and surface **6** casing strings and the cement sheath **10***c* without damaging the wall of the drive pipe **5**, thereby establishing access to the cement sheath **10***b* in an annulus **39** formed between the production and surface casing strings. After performing the perforation step, the sixth BHA **27** is retrieved to the lubricator and the lubricator is removed from the wellhead.

[0036] The fifth BHA **26** is then connected to the coiled tubing **22** and the injector head of the coiled tubing unit **15** is operated to lower the fifth BHA to the squeezing depth adjacent to and above the deep perforations **38**. Once the fifth BHA **26** has been deployed to the squeezing depth, the squeeze packer of the fifth BHA **26** is set. The squeeze pump **17** is operated to pump the sealant **28** from the blender **32** and into the coiled tubing **22** and then to chase the sealant with a secondary fluid such as seawater, thereby driving the sealant **28** through the coiled tubing **22** and into the annuli **36**, **39** via the casing perforations **38**. The sealant **28** flows into and through voids in the cement sheathes **10***b,c* present in the respective annuli **36**, **39**, thereby filling the voids and restoring the integrity thereof. The sealant **28** may also plug a portion of the cement sheath **10***c* adjacent to the surface casing string **6** and a portion of the cement sheath **10***b* adjacent to the drive pipe **5**.

[0037] FIGS. **6**A and **6**B illustrate a second alternative sealing operation, according to another embodiment of the present disclosure. In this second alternative sealing method, the third BHA is deployed into the production casing string **7** to an alternative setting depth adjacent to a top of the severed production tubing string **8** and adjacent to the wellbore wall instead of along a portion of the production casing string **7** adjacent to the surface casing string **6**. Once the third BHA has been deployed to the alternative setting depth, the bridge plug **23** is set and released from the setting tool. The third BHA (minus the bridge plug **23**) is then be retrieved to the lubricator and the lubricator is then removed from the wellhead.

[0038] The fourth BHA **24** is then connected to the wireline **19** in the lubricator and deployed through the wellhead. The fourth BHA **24** is deployed to an alternative firing depth adjacent to and above the bridge plug **23**. Once the fourth BHA **24** has been deployed to the alternative firing depth, electrical power or an electrical signal is supplied to the fourth BHA via the wireline **19** to fire the perforating gun into the production casing string **7**, thereby forming alternative casing perforations **40** through a wall thereof. The fourth BHA **24** is then retrieved to the lubricator and the lubricator is removed from the wellhead.

[0039] The fifth BHA **26** is then connected to the coiled tubing **22** and the injector head of the coiled tubing unit **15** is operated to lower the fifth BHA to an alternative squeezing depth adjacent to and above the alternative casing perforations **40**. Once the fifth BHA **26** has been deployed to the alternative squeezing depth, the squeeze packer of the fifth BHA **26** is set. The squeeze pump **17** is operated to pump the sealant **28** from the blender **32** and into the coiled tubing **22** and then to chase the sealant with a secondary fluid such as seawater, thereby driving the sealant **28** through the coiled tubing **22** and into the annulus **36** via the alternative casing perforations **40**. The sealant **28** flows into and through the voids in the cement sheath **10***c* present in the annulus **36** thereby filling the voids and restoring the integrity of the cement sheath. The sealant **28** thus plugs a portion of the cement sheath **10***c* adjacent to the wellbore wall.

[0040] FIGS. 7A and 7B illustrate a third alternative sealing operation, according to another embodiment of the present disclosure. In this alternative, the bridge plug **23** is set at the alternative setting depth. The sixth BHA **27** is then deployed to a second alternative firing depth adjacent to and above a shoe of the surface casing string **6** and fired to form alternative deep perforations **41** through walls of the production **7** and surface **6** casing strings and the cement sheath **10***c*.

[0041] The fifth BHA **26** is then connected to the coiled tubing **22** and the injector head of the coiled tubing unit **15** is operated to lower the fifth BHA to a second alternative squeezing depth adjacent to and above the alternative deep perforations **41**. Once the fifth BHA **26** has been deployed to the second alternative squeezing depth, the squeeze packer of the fifth BHA **26** is set. The squeeze pump **17** is operated to pump the sealant **28** from the blender **32** and into the coiled tubing **22** and then to chase the sealant with an alternative fluid such as seawater, thereby driving the sealant **28** through the coiled tubing **22** and into the annuli **36**, **39** via the casing perforations **38**. The sealant **28** flows into and through voids in the cement sheathes **10***b,c* present in the respective annuli **36**, **39**, thereby filling the voids and restoring the integrity thereof. The sealant **28** plugs a portion of the cement sheath **10***c* adjacent to the surface casing string **6** and a portion thereof adjacent to the wellbore wall. The sealant **28** may also plug a portion of the cement sheath **10***b* adjacent to the wellbore wall.

[0042] Alternatively, a pipe string is used instead of the coiled tubing **22** to transport the sealant into the wellbore **4**. The pipe string typically includes joints of drill pipe or production tubing connected together, such as by threaded couplings.

[0043] Alternatively, a cement plug is used instead of or in addition to the bridge plug **23**.

[0044] Alternatively, the well **2** may further include one or more intermediate casing strings between the surface **6** and production **7** casing strings and the sealant is squeezed into one or more annuli formed between the production casing string and the intermediate casing strings. Alternatively, the sealant is squeezed into an annulus formed between a liner string and a casing string and/or between the liner string and the wellbore wall.

[0045] Alternatively, the wellbore **4** may be subsea having a wellhead located adjacent to the seafloor and any of the sealing operations may be staged from an offshore drilling unit or an intervention vessel. Alternatively, the wellbore **4** may be subterranean and any of the sealing operations may be staged from drilling or workover rig located on a terrestrial pad adjacent thereto.

[0046] While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope of the invention is determined by the claims that follow.

1. A method for sealing a well, comprising:
placing an obstruction in a bore of an inner tubular string disposed in a wellbore;
forming an opening through a wall of the inner tubular string above the obstruction;
mixing a resin and a hardener to form a sealant; and
squeezing the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and an outer tubular string, thereby repairing a cement sheath present in the annulus.

2. The method of claim **1**, wherein:
the annulus is an inner annulus,
the opening is also formed through a wall of the outer tubular string, and
the sealant is also squeezed into an outer annulus, thereby repairing a cement sheath present in the outer annulus.

3. The method of claim **1**, wherein the inner and outer tubular strings are both casing strings.

4. The method of claim **1**, further comprising squeezing at least a portion of the sealant into a formation into which the inner tubular sting extends.

5. The method of claim **1**, further comprising squeezing at least a portion of the sealant into a formation into which the outer tubular sting extends.

6. The method of claim **1**, wherein the squeezing of the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and an outer tubular string comprises;
pumping the sealant through a tubular extending into the inner tubular string and having a fluid volume; and
thereafter pumping a quantity of chaser fluid into the tubular having at least the volume of the tubular.

7. The method of claim **1**, wherein:
the sealant is squeezed into the bore through coiled tubing, and
the method further comprises:
lowering the coiled tubing and a bottom hole assembly (BHA) through the bore; and
forming the obstruction by setting a squeeze packer of the BHA against an inner surface of the inner tubular string.

8. The method of claim **1**, wherein:
the wellbore is a subsea wellbore,
the method further comprises, prior to placing the obstruction:
severing an upper portion of a production tubing string disposed in the wellbore from a lower portion thereof; and

removing the upper portion of the production tubing string from the wellbore.

9. The method of claim **1**, wherein:

the resin is bisphenol F epoxide,

the hardener is selected from a group consisting of tetraethylenepentamine for a low temperature well and diethyltoluenediamine for a high temperature well, and

the resin is premixed with a diluent selected from a group consisting of alkyl glycidyl ether and benzyl alcohol, and

a weighting material having a specific gravity of at least 2 is mixed with the resin and the hardener.

10. A method for sealing a well, comprising:

placing an obstruction in a bore of an inner tubular string disposed in a wellbore;

forming an opening through a wall of the inner tubular string above the obstruction;

mixing a resin and a hardener to form a sealant; and

squeezing the sealant into the bore, through the opening, and into an annulus formed between the inner tubular string and the wellbore, thereby repairing a cement sheath present in the annulus.

11. The method of claim **10**, wherein:

the annulus is an inner annulus,

the opening is also formed through a wall of an outer tubular string, and

the sealant is also squeezed into an outer annulus, thereby repairing a cement sheath present in the outer annulus.

12. The method of claim **10**, wherein the inner tubular string is a casing string.

13. The method of claim **10**, wherein:

the sealant is squeezed into the bore through coiled tubing, and

the method further comprises:

lowering the coiled tubing and a bottom hole assembly (BHA) through the bore; and

setting a squeeze packer of the BHA against an inner surface of the inner tubular string.

14. The method of claim **10**, wherein:

the wellbore is a subsea wellbore,

the method further comprises, prior to placing the obstruction:

severing an upper portion of a production tubing string disposed in the wellbore from a lower portion thereof; and

removing the upper portion of the production tubing string from the wellbore.

15. The method of claim **1**, wherein:

the resin is bisphenol F epoxide,

the hardener is selected from a group consisting of tetraethylenepentamine for a low temperature well and diethyltoluenediamine for a high temperature well, and

the resin is premixed with a diluent selected from a group consisting of alkyl glycidyl ether and benzyl alcohol.

16. The method of claim **10**, wherein the density of the sealant corresponds to the density of fluid present in the well.

17. The method of claim **10**, wherein a viscosity of the sealant is between 50-2,000 cp.

18. The method of claim **10**, wherein:

the resin is premixed with a bonding agent, and

the bonding agent is silane.

19. A method of infiltrating openings in a cement liner on the exterior of a subsurface tubular, comprising:

preparing a sealant comprising:

an epoxide resin,

a hardener selected from a group consisting of tetraethylenepentamine for a low temperature well and diethyltoluenediamine for a high temperature well, wherein;

extending a conduit inwardly of the subsurface tubular to a location therein having at least one opening extending through the wall thereof, the opening located above an obstruction in the tubular and extending through the tubular in a location where a cement is present on the exterior of the tubular; and

pumping the sealant through the conduit and through the at least one opening in the wall of the tubular, and thence into openings in the cement.

20. The method of claim **19**, further comprising an obstruction between the conduit and the wall of the tubular in a location above the openings in the wall of the tubular before pumping the sealant.

* * * * *