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(54) **EXTENDED CHEMICAL TREATMENT IN SUBTERRANEAN WELLS**

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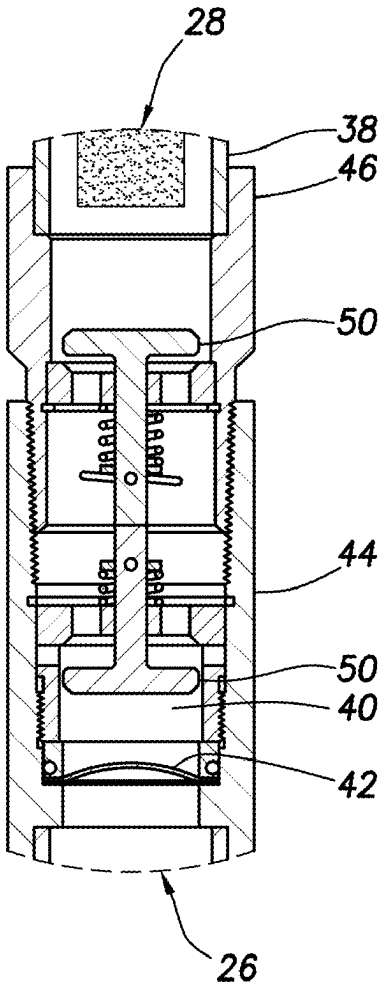
(57) **ABSTRACT**

A method of chemically treating a subterranean well can include connecting chemical treatment tools to each other, each of the chemical treatment tools including a respective chemical treatment, and deploying the treatment tools in the well, thereby contacting one chemical treatment with fluids in the well, while the other chemical treatment(s) remain isolated from the fluids in the well. A chemical treatment system can include multiple chemical treatment tools connected together, with a fluid passage extending between interiors of the chemical treatment tools, chemical treatments disposed in the respective interiors of the chemical treatment tools, and a fluid barrier blocking fluid flow through the fluid passage. A method of well tool actuation can include connecting well tools to each other with a fluid barrier, deploying the well tools into the well, and opening the fluid barrier, thereby actuating one of the well tools.



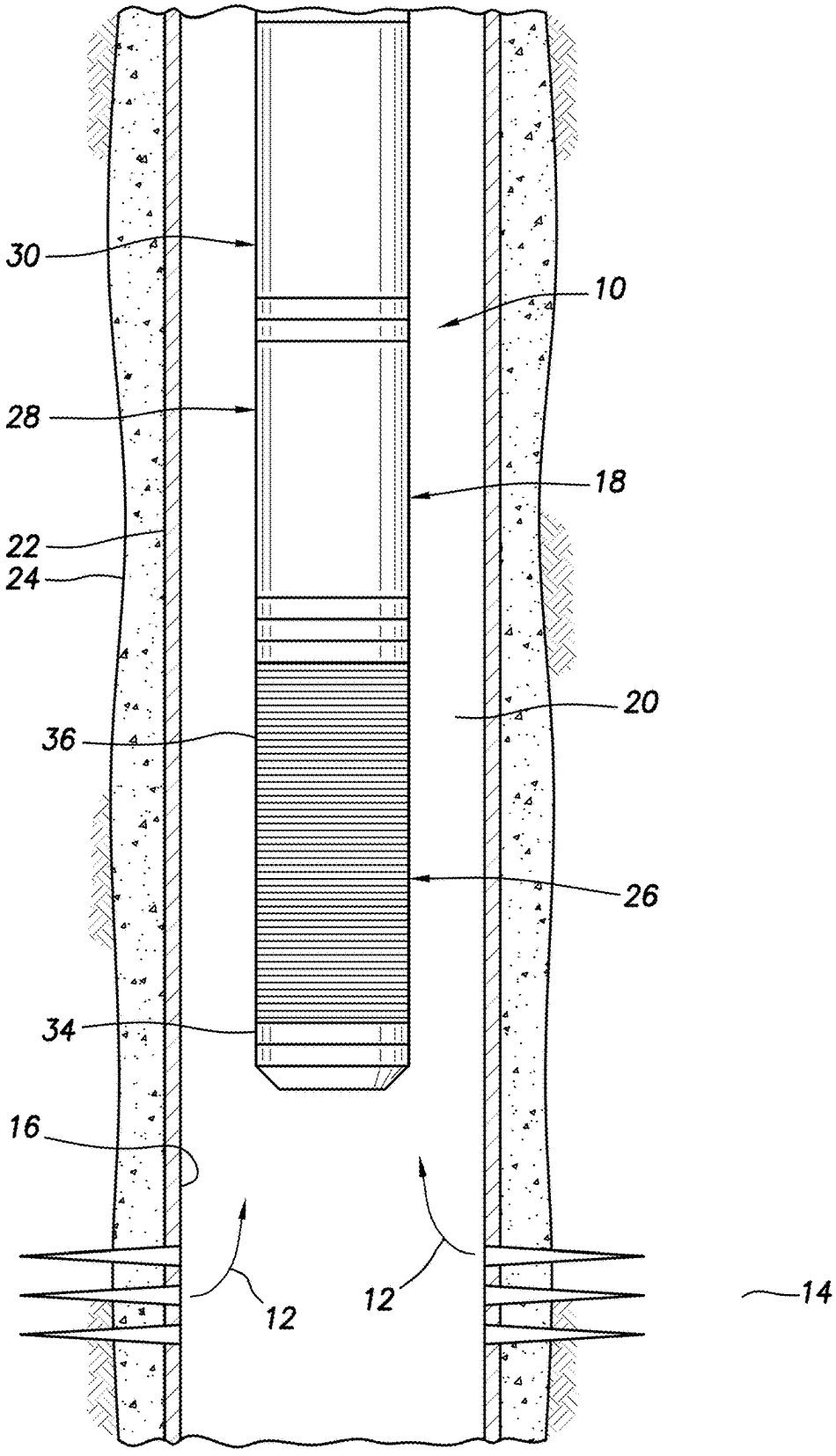


FIG. 1

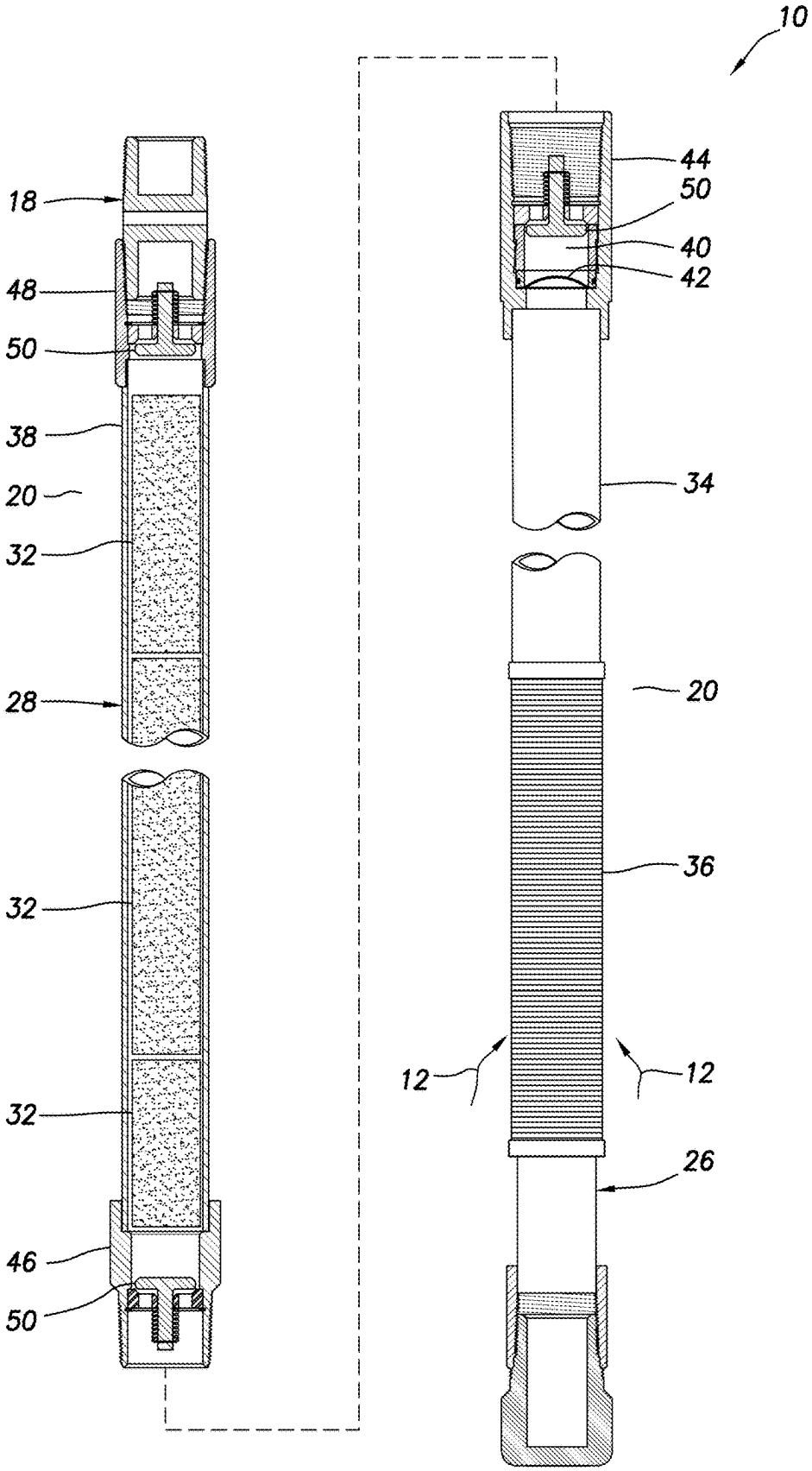
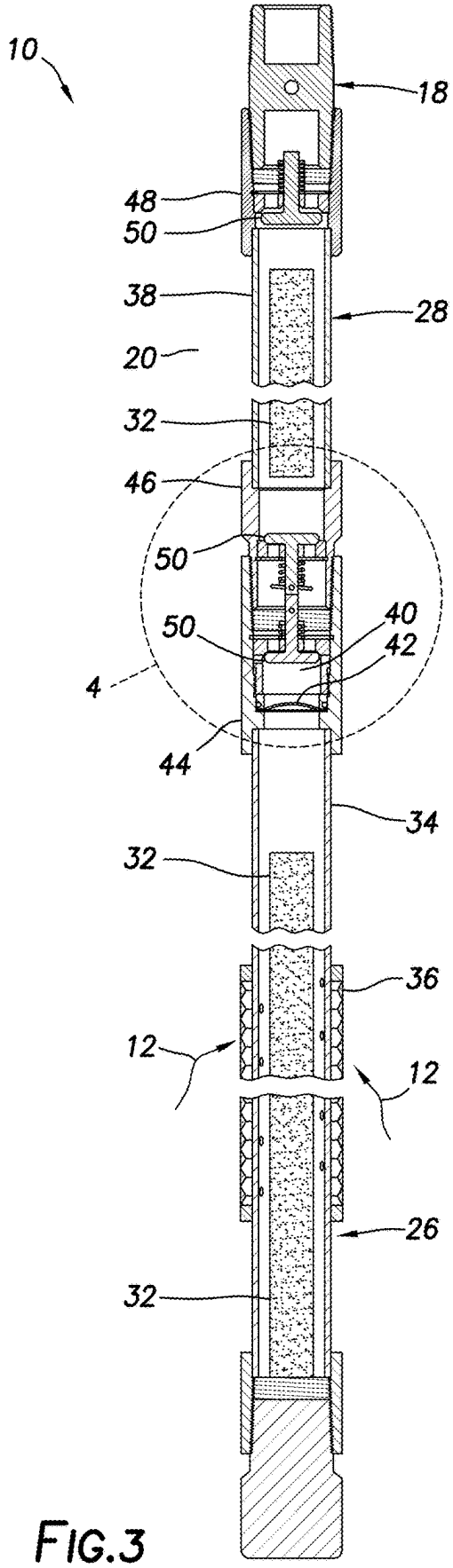


FIG.2


10
18
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12
26
32

FIG.3

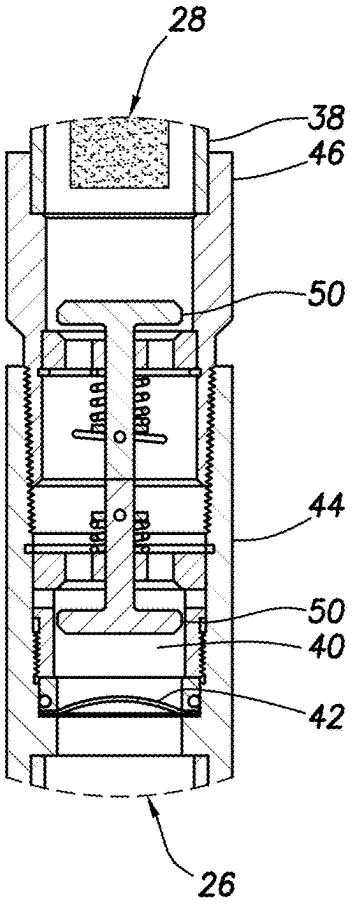
28
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FIG.4

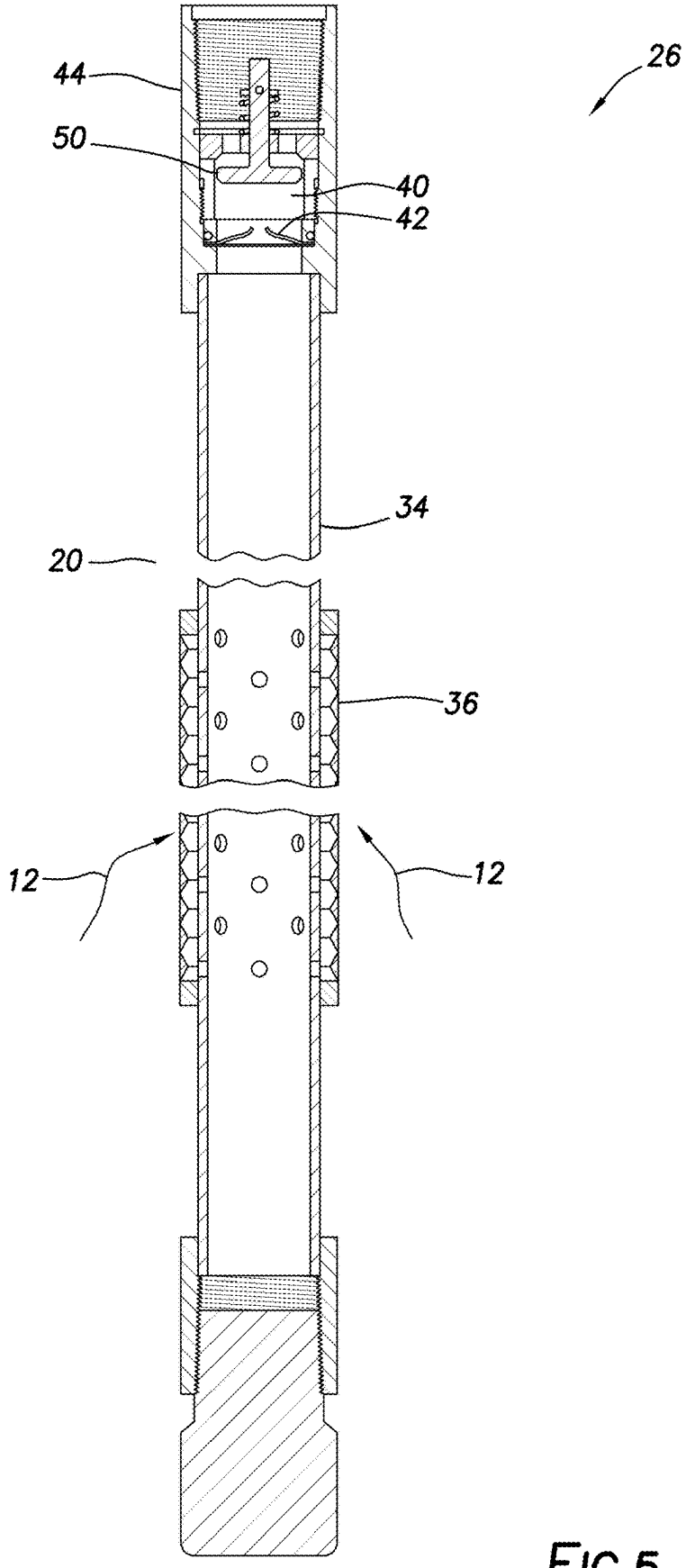

FIG.5

EXTENDED CHEMICAL TREATMENT IN SUBTERRANEAN WELLS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of the filing date of U.S. provisional application No. 63/555,633 filed on 20 Feb. 2024. The entire disclosure of the prior application is incorporated herein by this reference for all purposes.

BACKGROUND

[0002] This disclosure relates generally to equipment utilized and operations performed in conjunction with a subterranean well and, in an example described below, more particularly provides for extended chemical treatment in wells.

[0003] Chemical treatments may be used in wells for a variety of different purposes and combinations of purposes. For example, a particular chemical treatment may be useful for preventing paraffin accumulation in a producing wellbore, and another chemical treatment may be useful for preventing corrosion of tubulars in a producing or injection wellbore.

[0004] It will, therefore, be appreciated that improvements are continually needed in the art of designing, constructing and utilizing chemical treatment tools and other types of tools for use in wells. The present disclosure provides such improvements, which may be used in a wide variety of different well configurations and well operations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a representative partially cross-sectional view of an example of a well system and associated method which can embody principles of this disclosure.

[0006] FIG. **2** is a representative partially cross-sectional view of an example of a chemical treatment tool that may be used with the FIG. **1** system and method, and which can embody the principles of this disclosure.

[0007] FIG. **3** is a representative cross-sectional view of another example of the chemical treatment tool in a run-in configuration.

[0008] FIG. **4** is a representative cross-sectional view of a check valve mechanism of the chemical treatment tool, comprising detail '**4**' of FIG. **3**.

[0009] FIG. **5** is a representative cross-sectional view of a screen section of the chemical treatment tool in an actuated configuration.

DETAILED DESCRIPTION

[0010] Representatively illustrated in the accompanying drawings are a system and associated method which can embody principles of this disclosure. However, it should be clearly understood that the system and method are merely one example of an application of the principles of this disclosure in practice, and a wide variety of other examples are possible. Therefore, the scope of this disclosure is not limited at all to the details of the system and method described herein and/or depicted in the drawings.

[0011] The system includes an extended chemical treatment tool that, in one example, delivers a steady chemical treatment where it is most needed and effective—at or near a bottom of a wellbore. The tool in this example delivers a solid stick chemical blend that is tailored to counteract specific conditions unique to particular wellbore applications.

[0012] Depending on well conditions, chemical treatment may last for several months. When the chemical blend is depleted, treatment tapers off and eventually stops. Without access to additional solid stick chemical blend, the options are limited, for example, to cease treatment or pull the well completion and replace the tool.

[0013] Solid stick chemical blend within the tool described herein makes contact with wellbore fluid and begins to liquify, providing chemical treatment. Dispersion of chemical blend into the wellbore fluid occurs through perforations in the tool assembly.

[0014] Vee-wire (or other type) screen regulates the rate of dispersion. The use of a rupture disc or other openable barrier allows for extended treatment time. Solid stick chemical blend is isolated and contained within one or more tool isolated sections until access to the isolated section(s) is activated.

[0015] When the operator determines there is a need to introduce additional chemical blend to the wellbore, casing pressure is increased, forcing fluid through perforations in the tool, until the rupture disc bursts or the barrier is otherwise opened. This allows for well fluid to contact the chemical blend material stored within the tool isolated section and begin treatment again.

[0016] In another example, the rupture disc or other barrier may be used to actuate or activate other types of well tools, such as sand control tools.

[0017] A tool, system and method for extending a chemical treatment in a subterranean well is described herein, in which a second chemical treatment is exposed to well fluid after a first chemical treatment is exposed to the well fluid.

[0018] A barrier is opened to expose the second chemical treatment to the well fluid. The barrier may comprise a rupture disc.

[0019] The barrier may be opened by increasing pressure in the well. The pressure may be increased in an annulus between the tool and a wellbore of the well.

[0020] The second chemical treatment may be positioned in a tubular housing connected above a screen that filters fluid communication between an interior of the tubular housing and an annulus between the tool and a wellbore of the well.

[0021] Also described herein is a tool, system and method, in which rupturing a rupture disc or otherwise opening a barrier is used to activate or actuate another well tool.

[0022] Referring specifically now to FIG. **1**, a partially cross-sectional view of an example of a system **10** for chemically treating a well (or fluids **12** in the well) is representatively illustrated. In this example, the fluids **12** are at least in part produced from an earth formation **14** surrounding a wellbore **16** of the well. In other examples, the fluids **12** may comprise fluids flowed into the well (such as, from the surface via a tubular string or an annulus formed between the tubular string and the wellbore) or other fluids present in the wellbore **16**.

[0023] As depicted in FIG. **1**, a tubular string **18** has been deployed into the wellbore **16**. An annulus **20** is formed radially between an exterior surface of the tubular string **18** and the wellbore **16**. In this example the wellbore **16** is lined

with casing **22** and cement **24**, but in other examples, the tubular string **18** could extend into an uncased or open hole section of the wellbore.

[0024] The tubular string **18** in this example includes multiple chemical treatment tools **26**, **28**, **30** connected together. The tool **30** may be the same as or similar to the tool **28**. Any number, type or combination of tools may be used in the tubular string **18**, in keeping with the scope of this disclosure.

[0025] A chemical treatment **32** (see FIG. **2**) is disposed in a respective interior of each of the well tools **26**, **28**, **30**. The chemical treatment **32** in the tool **26** is exposed to and contacted with the well fluids **12** immediately when the tubular string **18** is deployed into the wellbore **16**.

[0026] In this example, this fluid contact is due to the tool **26** including an outer housing **34** that is perforated and provided with a screen **36** that filters fluid flow between the interior and an exterior of the outer housing (the annulus **20** in the FIG. **1** example). In contrast, the tools **28**, **30** include outer housings **38** that are not perforated and do not permit fluid communication between their interiors and exteriors.

[0027] The interiors of the tools **28**, **30** are isolated from the wellbore **16**, so the chemical treatments **32** therein are not exposed to or contacted with the well fluids **12**, when the tubular string **18** is deployed into the well. Instead, the chemical treatments **32** in the interiors of the tools **28**, **30** are exposed to or contacted with the well fluids **12** only after the tubular string **18** is deployed into the well and the chemical treatment in the tool **26** has been exposed to or contacted with the well fluids.

[0028] In this manner, a duration of chemical well treatment deployment is extended. The extended duration results from exposing the chemical treatments **32** in the different respective tools **26**, **28**, **30** to the well fluids **12** in series (one after another), rather than in parallel (at the same time).

[0029] However, note that the chemical treatments **32** in two or more of the tools **26**, **28**, **30** may be simultaneously exposed to or contacted with the well fluids **12** in keeping with the scope of this disclosure. For example, the chemical treatment **32** in the tool **28** may be exposed to or contacted with the well fluids **12** after the chemical treatment in the tool **26** is exposed to or contacted with the well fluids, but before the chemical treatment in the tool **26** is completely dissolved or dispersed.

[0030] Referring additionally now to FIG. **2**, a partially cross-sectional view of examples of the chemical treatment tools **26**, **28** connected together in the tubular string **18** is representatively illustrated. Any number of each of the tools **26**, **28** may be used in the tubular string **18**. For convenience, the FIG. **2** tubular string **18** is described below as it may be used with the FIG. **1** system **10** and method, but the FIG. **2** tubular string **18** may be used with other systems and methods in keeping with the scope of this disclosure.

[0031] As depicted in FIG. **2**, multiple chemical treatments **32** are contained in the outer housing **38** of the tool **28**. The chemical treatments **32** are isolated from an exterior of the tool **28**. Thus, when the tubular string **18** is deployed into the wellbore **16**, the chemical treatments **32** are not contacted with or exposed to the well fluids **12**.

[0032] One or more chemical treatments **32** are also contained in the outer housing **34** of the tool **26**. However, the outer housing **34** is perforated or otherwise permits fluid communication between the interior and exterior of the outer housing. Thus, when the tubular string **18** is deployed into the wellbore **16**, the chemical treatment **32** in the tool **26** is contacted with or exposed to the well fluids **12**.

[0033] A fluid passage **40** extends between the interior of the outer housing **34** and the interior of the outer housing **38**. Initially, fluid flow through the fluid passage **40** is prevented or blocked by a fluid barrier **42**. In this example, the fluid barrier **42** is in the form of a rupture disc **42** positioned in a coupler **44** configured to connect the tools **26**, **28** to each other. However, other types of fluid barriers (such as, valves, diaphragms, plugs, etc.) and other positions of the fluid barrier may be used in other examples.

[0034] In the FIG. **2** example, the tools **26**, **28** are connected to each other (and to additional tools **30** in other examples) with couplers **44**, **46**, **48** comprising check valves or pressure containment valves **50**. The valves **50** are opened when the couplers **44**, **46** are appropriately connected to each other. Suitable couplers and valves are described in U.S. Pat. No. 11,454,090, the entire disclosure of which is incorporated herein by this reference for all purposes.

[0035] When it is desired to expose the chemical treatment (s) **32** in the tool **28** to the well fluids **12**, a sufficient pressure differential is applied across the barrier **42** to cause the barrier to be opened. In the FIG. **2** example, the pressure differential is from the interior of the tool **26** (or the exterior of the tool **26**, since the interior and exterior are in fluid communication) to the interior of the tool **28**.

[0036] For example, increased pressure may be applied to the annulus **20** on the exterior of the tool **26**, which will also be communicated via the housing **34** and screen **36** to the interior of the tool **26**. In this manner the pressure differential is created across the barrier **42** sufficient to cause the barrier to be opened. In the FIG. **2** example, the pressure differential corresponds to the pressure differential across the rupture disc that is sufficient to cause the rupture disc to rupture. When the rupture disc is ruptured, fluid communication will be permitted between the interiors of the tools **26**, **28**, and the chemical treatments **32** in the tool **28** will be exposed to or contacted with the well fluids **12**.

[0037] Referring additionally now to FIG. **3**, a partially cross-sectional view of another example of the tubular string **18** is representatively illustrated. In this view, the couplers **44**, **46** are connected to each other, thereby connecting the tools **26**, **28**.

[0038] In FIG. **4**, the manner in which the valves **50** in the couplers **44**, **46** are opened when the couplers are connected to each other can be seen. Thus, when the tools **26**, **28** are connected to each other, the interior of the tool **26** can communicate with the interior of the tool **28** if the barrier **42** is opened (e.g., by applying sufficient pressure in the interior of the tool **26** to cause the barrier to open or rupture).

[0039] Referring additionally now to FIG. **5**, a cross-sectional view of an example of the chemical treatment tool **26** in an actuated configuration is representatively illustrated. In this view, the chemical treatment **32** in the interior of the housing **34** is completely or substantially dissolved or dispersed.

[0040] The fluid barrier **42** has been opened by application of increased pressure to the exterior (e.g., the annulus **20**) and interior of the tool **26**. The resulting pressure differential across the barrier **42** has caused the barrier to rupture in this example, thereby permitting fluid communication through the fluid passage **40** between the interiors of the tools **26**, **28**.

[0041] Thus, the well fluids **12** contact the chemical treatment **32** in the tool **28** when the barrier **42** is opened. The

dissolved or dispersed chemical treatment **32** due to the well fluids **12** contacting the chemical treatment in the tool **28** can be communicated to the wellbore **16** or annulus **20** via the open fluid passage **40**, the open fluid barrier **42**, the interior of the housing **34** and the screen **36**.

[0042] Note that the chemical treatment tools **26**, **28**, **30** are merely examples of types of well tools that can be actuated using the features of the invention as disclosed herein. In other examples, the tools **26**, **28**, **30** could be other types of well tools, such as, sand control equipment, completion equipment, fluid separation equipment, etc.

[0043] It may now be fully appreciated that the above disclosure provides significant improvements to the art of designing, constructing and utilizing chemical treatment tools and other types of tools for use in wells. In examples described above, multiple chemical treatment tools **26**, **28** can be deployed into a well, with at least one of the tools **26** having a chemical treatment **32** that is exposed to well fluids **12**, and at least one other tool **28** having a chemical treatment that is not exposed to the well fluids. The second chemical treatment **32** can be exposed to the well fluids **12** a selectable delay after the tools **26**, **28** are deployed in the well (such as, when the chemical treatment has completely or substantially dissolved or dispersed).

[0044] The above disclosure provides to the art a method of chemically treating a subterranean well. In one example, the method can comprise: connecting at least a first chemical treatment tool **26** to a second chemical treatment tool **28**, the first chemical treatment tool **26** including a first chemical treatment **32**, and the second chemical treatment tool **28** comprising a second chemical treatment **32**; and deploying the first and second chemical treatment tools **26**, **28** in the well, thereby contacting the first chemical treatment **32** with fluids **12** in the well, while the second chemical treatment **32** remains isolated from the fluids **12** in the well.

[0045] The method may include contacting the second chemical treatment **32** with the fluids **12** in the well only after the first chemical treatment **32** is in contact with the fluids **12** in the well. The step of contacting the second chemical treatment may include opening a fluid barrier **42** between the first and second chemical treatments **32**. The opening step may include applying increased pressure to the fluid barrier **42** in the well.

[0046] The step of contacting the second chemical treatment **32** may include opening a rupture disc. The step of contacting the second chemical treatment **32** may include opening a fluid passage **40** extending between an interior of a first outer housing **34** of the first chemical treatment tool **26** and an interior of a second outer housing **38** of the second chemical treatment tool **28**.

[0047] The fluids **12** in the well may also be in the interior of the first outer housing **34** after the deploying step and prior to the opening step. The interior of the second outer housing **38** may be isolated from the fluids **12** in the well after the deploying step and prior to the opening step.

[0048] The fluids **12** in the well may also be in the interior of the first outer housing **34** after the deploying step and after the opening step. The fluids **12** in the well may also be in the interior of the second outer housing **38** after the deploying step and after the opening step.

[0049] The above disclosure also provides to the art a chemical treatment system **10** for use with a subterranean well. In one example, the system **10** can comprise: at least first and second chemical treatment tools **26**, **28** connected together, with a fluid passage **40** extending between interiors of the first and second chemical treatment tools **26**, **28**; at least first and second chemical treatments **32** disposed in the respective interiors of the first and second chemical treatment tools **26**, **28**; and a fluid barrier **42** blocking fluid flow through the fluid passage **40**.

[0050] The fluid barrier **42** may comprise a rupture disc.

[0051] The interior of the first chemical treatment tool **26** may be in fluid communication with an exterior of the first chemical treatment tool **26**. The interior of the second chemical treatment tool **28** may be isolated from an exterior of the second chemical treatment tool **28**.

[0052] The first chemical treatment **32** may be disposed in an outer housing **34** of the first chemical treatment tool **26**. The outer housing **34** may be perforated.

[0053] The outer housing **34** may comprise a screen **36** configured to filter fluid **12** flow between the interior and an exterior of the outer housing **34**. The exterior of the outer housing **34** may comprise an annulus **20** formed between the outer housing **34** and a wellbore **16** of the well.

[0054] A method of well tool actuation in a subterranean well is also described above. in one example, the method can comprise: connecting at least first and second well tools **26**, **28** to each other, at least one of the well tools **26**, **28** comprising a fluid barrier **42**; deploying the first and second well tools **26**, **28** into the well; and opening the fluid barrier **42**, thereby actuating the second well tool **28**.

[0055] The fluid barrier **42** may comprise a rupture disc. The opening step may include increasing fluid pressure in the well.

[0056] The actuating step may include admitting fluids **12** in the well to flow into an interior of the second well tool **28**. The fluid barrier **42** may block fluid flow through a fluid passage **40** extending between interiors of the first and second well tools **26**, **28**.

[0057] Although various examples have been described above, with each example having certain features, it should be understood that it is not necessary for a particular feature of one example to be used exclusively with that example. Instead, any of the features described above and/or depicted in the drawings can be combined with any of the examples, in addition to or in substitution for any of the other features of those examples. One example's features are not mutually exclusive to another example's features. Instead, the scope of this disclosure encompasses any combination of any of the features.

[0058] Although each example described above includes a certain combination of features, it should be understood that it is not necessary for all features of an example to be used. Instead, any of the features described above can be used, without any other particular feature or features also being used.

[0059] It should be understood that the various embodiments described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., and in various configurations, without departing from the principles of this disclosure. The embodiments are described merely as examples of useful applications of the principles of the disclosure, which is not limited to any specific details of these embodiments.

[0060] In the above description of the representative examples, directional terms (such as "above," "below," "upper," "lower," "upward," "downward," etc.) are used for convenience in referring to the accompanying drawings.

However, it should be clearly understood that the scope of this disclosure is not limited to any particular directions described herein.

[0061] The terms "including," "includes," "comprising," "comprises," and similar terms are used in a non-limiting sense in this specification. For example, if a system, method, apparatus, device, etc., is described as "including" a certain feature or element, the system, method, apparatus, device, etc., can include that feature or element, and can also include other features or elements. Similarly, the term "comprises" is considered to mean "comprises, but is not limited to."

[0062] Of course, a person skilled in the art would, upon a careful consideration of the above description of representative embodiments of the disclosure, readily appreciate that many modifications, additions, substitutions, deletions, and other changes may be made to the specific embodiments, and such changes are contemplated by the principles of this disclosure. For example, structures disclosed as being separately formed can, in other examples, be integrally formed and vice versa. Accordingly, the foregoing detailed description is to be clearly understood as being given by way of illustration and example only, the spirit and scope of the invention being limited solely by the appended claims and their equivalents.

What is claimed is:

1. A method of chemically treating a subterranean well, the method comprising:

connecting at least a first chemical treatment tool to a second chemical treatment tool, the first chemical treatment tool including a first chemical treatment, and the second chemical treatment tool comprising a second chemical treatment; and

deploying the first and second chemical treatment tools in the well, thereby contacting the first chemical treatment with fluids in the well, while the second chemical treatment remains isolated from the fluids in the well.

2. The method of claim **1**, further comprising contacting the second chemical treatment with the fluids in the well only after the first chemical treatment is in contact with the fluids in the well.

3. The method of claim **2**, in which the contacting the second chemical treatment comprises opening a fluid barrier between the first and second chemical treatments.

4. The method of claim **3** in which the opening comprises applying increased pressure to the fluid barrier in the well.

5. The method of claim **2**, in which the contacting the second chemical treatment comprises opening a rupture disc.

6. The method of claim **2**, in which the contacting the second chemical treatment comprises opening a fluid passage extending between an interior of a first outer housing of the first chemical treatment tool and an interior of a second outer housing of the second chemical treatment tool.

7. The method of claim **6**,

in which the fluids in the well are also in the interior of the first outer housing after the deploying and prior to the opening, and

in which the interior of the second outer housing is isolated from the fluids in the well after the deploying and prior to the opening.

8. The method of claim **7**,

in which the fluids in the well are also in the interior of the first outer housing after the deploying and after the opening, and

in which the fluids in the well are also in the interior of the second outer housing after the deploying and after the opening.

9. A chemical treatment system for use with a subterranean well, the system comprising:

at least first and second chemical treatment tools connected together, with a fluid passage extending between interiors of the first and second chemical treatment tools;

at least first and second chemical treatments disposed in the respective interiors of the first and second chemical treatment tools; and

a fluid barrier blocking fluid flow through the fluid passage.

10. The system of claim **9**, in which the fluid barrier comprises a rupture disc.

11. The system of claim **9**, in which the interior of the first chemical treatment tool is in fluid communication with an exterior of the first chemical treatment tool.

12. The system of claim **11**, in which the interior of the second chemical treatment tool is isolated from an exterior of the second chemical treatment tool.

13. The system of claim **9**, in which the first chemical treatment is disposed in an outer housing of the first chemical treatment tool, and in which the outer housing is perforated.

14. The system of claim **9**, in which the first chemical treatment is disposed in an outer housing of the first chemical treatment tool, and in which the outer housing comprises a screen configured to filter fluid flow between the interior and an exterior of the outer housing.

15. The system of claim **14**, in which the exterior of the outer housing comprises an annulus formed between the outer housing and a wellbore of the well.

16. A method of well tool actuation in a subterranean well, the method comprising:

connecting at least first and second well tools to each other, at least one of the well tools comprising a fluid barrier;

deploying the first and second well tools into the well; and

opening the fluid barrier, thereby actuating the second well tool.

17. The method of claim **16**, in which the fluid barrier comprises a rupture disc.

18. The method of claim **16**, in which the opening comprises increasing fluid pressure in the well.

19. The method of claim **16**, in which the actuating comprises admitting fluids in the well to flow into an interior of the second well tool.

20. The method of claim **16**, in which the fluid barrier blocks fluid flow through a fluid passage extending between interiors of the first and second well tools.

* * * * *