A spear guide mechanism for locating and becoming retrievably attached to a separated string of tubing within a multiple tubing well casing may include a tubing retrieval element that generally conforms to the internal size and configuration of the casing of the well and is adapted to be lowered into the well through the use of a fishing pipe string or through the use of any other suitable lowering mechanism. At least two guide passages or channels may be formed in the tubing retrieval element, one or more of the channels conforming to the position of the unseparated string or strings of tubing and being of a size to pass over the collars of the unseparated tubing and one of the channels conforming to the relative position of the separated tubing string and being of a size for close fitting relation with the outer diameter of the separated tubing string. A spear may be disposed within the guide channel for the separated tubing string and becomes inserted into the separated tubing upon movement of the tubing retrieval element into fully received relation with the separated tubing string. Outwardly diverging cam surface means may be formed on the tubing retrieval element and may serve to urge the spear guide mechanism into properly oriented relation with the separated tubing string.

Primary Examiner—Richard A. Schacher
Assistant Examiner—Johnny D. Cherry

ABSTRACT

A spear guide mechanism for locating and becoming...
SPEAR GUIDE MECHANISM FOR USE IN MULTIPLE TUBING WELL CASINGS

FIELD OF THE INVENTION

This invention relates generally to fishing within wells for objects disposed therein and more particularly, the invention relates to fishing for separated tubing strings within multiple completion wells having a plurality of tubing strings for production of fluid from a plurality of production zones.

BACKGROUND OF THE INVENTION

Many, if not most, recently drilled oil wells are designed for production from two or more production zones at different depths within the respective well bore. Wells having two or more tubing strings for the purpose of producing petroleum products such as oil, gas, distillate, etc., are referred to as multiple completion wells or more specifically as dual, triple or quadruple completions depending upon the number of production zones being produced. Most wells are dual completion wells having a pair of tubing strings extending from a well head downwardly to the different production zones.

Where multiple completions are involved, it is typical for tubing extending to the deepest production zone to be of larger diameter, since the tubing string must be capable of supporting its own weight as it hangs from the well head. As an example, a nominal 5 1/2 inch casing having an internal diameter of approximately 5 inches (more or less depending upon the weight of the casing) may contain two tubing strings for production of petroleum products from two different producing regions or sands to which the well bore extends. The larger of the tubing strings will typically have a nominal internal diameter of two inches and an outer diameter ranging from 2 3/8 inches along the tube body to a maximum of 3 1/16 inches outer diameter at the collars that secure the sections of tubing into assembly. The second tubing string will be smaller, the actual size typically depending upon the remaining available space within the casing.

Since wells may be continuously producing petroleum products for an extended period of time and in view of the fact that the well environment is typically hostile in that the fluid being produced can be both corrosive and erosive, it is not unusual for one of the tubing strings of the well to become separated because of metal failure. One cause of metal failure is typically referred to in the metallurgical field as hydrogen embrittlement, which occurs when a metal is maintained under a condition of stress for extended periods of time in the presence of a fluid having a hydrogen sulfide content. In the petroleum industry, many wells produce crude oil gas and other petroleum products having what is considered to be a high percentage of hydrogen sulfide. The well fluid so produced is typically referred to in the industry as sour crude, sour gas, etc.

In a multiple completion well when one of the tubing strings fails and separates it is of course necessary to remove that tubing string from the well for repairs and/or replacement. Retrieval of the lower portion of the separated tubing string has previously been an extremely difficult and costly operation, often necessitating removal of the remaining unseparated producing tubing string down to the level of the break to enable successful fishing for the separated tubing. This procedure is highly unsatisfactory, not only in terms of the production lost but of the time and expense of removing and replacing the good tubing string.

It is a primary object of the present invention therefore to provide a novel tubing retrieval mechanism that effectively allows retrieval of the lower portion of the separated tubing without in any way disturbing the unseparated tubing string or strings within the well casing.

It is a further object of the present invention to provide a novel tubing retrieval mechanism that utilizes the unseparated tubing string or strings within the well casing as a guide to orient a tubing retrieval spear mechanism carrier thereby in position for retrieving engagement with the separated portion of the tubing string that is to be raised to the surface for repair or replacement.

It is an even further object of the present invention to provide a novel tubing retrieval mechanism having a cross-sectional configuration substantially filling the casing of the well with exception of a guide channel that substantially conforms to the configuration and dimension of the collars of an unseparated tubing string and which further includes a retrieving bore or guide passage that is lowered about the upper portion of the separated tubing and which positions the tubing retrieval spear in position for insertion into the tubing to be received.

It is also an object of the present invention to provide a novel tubing retrieval mechanism that is of simple nature, is reliable in use and low in cost.

Other and further objects, advantages and features of the present invention will become apparent to one skilled in the art upon full consideration of the present disclosure. The form of the invention, which will now be described in detail, illustrates the general principles of the invention, but it is to be understood that this detailed description is not to be taken as limiting the scope of the present invention.

SUMMARY OF THE INVENTION

A preferred embodiment of the present invention may conveniently take the form of an elongated body having a cross-sectional configuration generally conforming to the cross-sectional configuration of a well casing into which it is to be received and having an external dimension that is slightly smaller than the internal dimension of the casing thereby enabling the elongated element to be readily lowered through the casing and also allowing the elongated element to utilize the casing wall structure for cooperative guide purposes in becoming located in retrieving relation to a broken tubing string disposed within the well bore. The elongated element may have a first guide channel formed therein along the length thereof, which guide channel may be of similar configuration and slightly larger than the collars of the unseparated tubing string within the well casing. The unseparated tubing string of a dual completion well is received within the first guide channel thereby allowing the elongated element to be positioned within the well casing by the cooperative relationship of the unseparated tubing string and the internal wall structure of the casing.

A second guide channel or bore may be formed in the elongated body portion of the tubing retrieval mechanism in generally parallel relation with the first guide channel and, like the first guide channel, being in offset relationship to the axis of the casing. The second guide
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channel is of sufficient dimension to receive the upper extremity of the separated tubing in guiding relation therein. A spear mechanism may be carried within the body of the tubing retrieval mechanism in substantially concentric relation to the second guide channel and may be inserted into the upper extremity of the broken tubing upon substantially full movement of the second guide channel into fully received relationship with the upper extremity of the broken tubing. The lower extremity of the elongated body portion of the tubing retrieval mechanism may be provided with a cam surface, which engages the upper portion of the broken tubing string and serves to impart movement of the tubing retrieval mechanism into proper alignment with the upper extremity of the broken tubing string, thereby compensating for minor misalignment that may occur due to shifting of the broken tubing string after breakage occurs.

A downwardly facing shoulder may be defined at the upper extremity of the second guide channel which shoulder may be engaged by an annular enlargement formed on the tubing retrieval spear, thereby enabling the spear and the tubing retrieval body to be removed as a unit. A cooperative relationship between the downwardly facing shoulder and the enlargement defined by the tubing retrieval spear functions to enhance the gripping relationship between the spear and the internal wall structure of the separated tubing during lifting of the separated tubing from the well.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features, advantages, and objects of the present invention, as well as others, which will become apparent, are attained and understood in detail, more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings, which drawings form a part of this specification.

It is to be noted however that the appended drawings illustrate only typical embodiments of the invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

IN THE DRAWINGS:

FIG. 1 is a fragmentary sectional view of a dual completion well having a casing cemented within a well bore and having two tubing strings, the smaller of which is shown to be separated and depicting a tubing retrieval mechanism constructed in accordance with the present invention in position for receiving the upper extremity of the separated tubing string.

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1.

FIG. 3 is a sectional view similar to that depicted in FIG. 2 and illustrating the relative position of the large and small tubing strings of the well in relation to the first and second guide channels of the tubing retrieval mechanism.

FIG. 4 is a sectional view of the body portion of the tubing retrieval mechanism of the present invention with the spear mechanism separated therefrom.

FIG. 5 is a transverse sectional view of the body portion of a tubing retrieval mechanism representing a modified embodiment of the present invention.

FIG. 6 is a transverse sectional view of a further modified embodiment of the present invention depicting a tubing retrieval mechanism designed for retrieval operations in connection with a triple completion well.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings and first to FIG. 1, there is depicted a well bore 12 defined in an earth formation 14. The well, as better determined from the sectional views set forth in FIGS. 2 and 3, is a dual completion well having a large diameter tubing string 16 and a small diameter tubing string 18, the smaller of the two strings being shown to be broken thereby necessitating fishing operations for removal of the broken tubing or "fish" from the casing of the well. As shown in FIG. 1, the large tubing string is provided with a plurality of collars 20 that serve as connectors between the joints of tubing, the collars defining a circular dimension that is substantially larger than the circular dimension of the tubing. The small diameter tubing will also be connected by means of collars, not shown, but it is highly unusual for tubing breakage to occur at a collar, hence it is not typically necessary to consider the external dimension of the collars of the smaller tubing string when fishing operations are involved. Although the smaller tubing string is shown to be broken, and it is typical for the smaller tubing string to break rather than the larger tubing string, this is not necessarily always the case but at times the larger tubing string will become broken while the smaller tubing string remains intact. The present invention will function efficiently however regardless of the particular tubing string that has become broken but, of course, the design of a tubing retrieval mechanism for retrieval of the large tubing string will be different from that shown in the drawings of the present invention by virtue of the location and dimension of the tubing spear mechanism.

It will be desirable to provide a mechanism that may be lowered into the well without disturbing the unbroken tubing string and which will move readily into assembled connected relationship with the upper extremity of the broken tubing string and which will function efficiently to withdraw the broken portion of the tubing string from the well in simple and efficient manner and without excessive down time of the well. According to the present invention one suitable means for retrieving the broken portion of a tubing string may conveniently take the form illustrated in FIGS. 1–4 of the drawings where an elongated body element 22 is provided that may have an elongated guide recess or channel 24 formed therein which channel may be of generally circular cross-sectional configuration and may be slightly larger than the outer dimension of the collar ports 20 of the large tubing string 16 of the well. Due to the fact that the collars of the large tubing string are typically positioned quite closely to the internal wall 26 of the casing 10, an elongated side portion of the body 22 is cut away in such manner as to define an elongated slot 28 thereby enabling the generally cylindrical internal wall 24 to surround approximately 270° of the collar ports 20 of the larger tubing. This enables sufficient guiding contact to be established between the large tubing, the body structure 22 and the internal wall 26 of the casing to control the position of the body structure 22 within the casing within rather narrow limits.
The tubing retrieval mechanism must also include means for locating the upper portion of the broken tubing or fish and for establishing positive connection therewith in order that the fish may be raised to the surface for repair or replacement. One suitable means for accomplishing such location and connection may conveniently take the form illustrated in the drawings wherein a second guide channel or bore 30 may be formed in the body structure 22 and may have a generally cylindrical cross-sectional configuration as shown in FIG. 2 and may be slightly larger than the outer dimension of the fish to which attachment is desired. In view of the fact that the upper extremity of the fish may be misaligned with the guide channel 30 as the body structure 22 is lowered relative to the casing and tubing structure, a downwardly and outwardly diverging tapered cam surface 32 may be defined at the lower extremity of the body 22 and may, when engaging the upper extremity of the fish, cause the body 22 to be shifted slightly about the larger tubing 16 in such manner as to bring the bore 30 into positive receiving alignment with the upper extremity of the fish. Likewise, the upper extremity of the fish may be moved slightly by engagement between the fish and the cam surface 32, thereby also accomplishing receiving alignment between the fish and the guide channel or bore 30.

At the upper extremity of the body 22 may be defined a reduced diameter portion 34 defining a downwardly facing internal shoulder 36 that provides an annular support surface for a collar portion 38 of a spear mechanism illustrated generally at 40. The collar portion 38 of the spear mechanism may be removably connected in any suitable manner to a reduced diameter connector stem portion 42 of a fishing string 44 that may be composed of pipe of sufficient strength to withstand the force necessary to withdraw the broken lower portion of the tubing 18. Additionally, the fishing string 44 may be composed of a wire line retrieval tool that supports the tubing retrieval mechanism. The wire line may take the form of a cable of sufficient strength for imparting the necessary force to the fish for removal of the fish from the well.

The tubing retrieval spear 40 may be of any suitable commercially available type that is introduced into the broken tubing and is manipulated in such manner as to expand and cause gripping engagement to occur between the spear and the tubing. The lower portion of the spear may be provided with a tapered cam portion 46 thereby enabling any minor misalignment to be overcome as the spear is inserted into the tubing 18. Typically, as the spear is fully inserted into the tubing, the upper extremity of the fish will engage a downwardly directed shoulder 48 defined by the collar 38 and will cause mechanical pressure to be exerted between the tubing 18 and the shoulder 48 which results in expansion of the toothed portion 50 of the spear into positively locked engagement with the internal wall structure of the tubing. After such connection has been established, the fishing string 44 is moved upwardly and the reaction between the collar 38 and the downwardly directed support shoulder 36 causes further manipulation of the toothed portion 50 of the spear to occur thereby allowing the weight of the broken tubing 18 to embrace the gripping function of the spear as surface 32.

The internal wall structure of the casing may have minor obstructions that would interfere with upward movement of the tubing retrieval mechanism as the small broken tubing string 18 is removed from the well. To alleviate possible jamming of the body structure 22 of the tubing retrieval mechanism on a casing projection, the body portion 22 is provided with a tapered upper portion 52 that defines a cam surface that will effectively cause the tubing retrieval mechanism to be shifted slightly upon contacting a tubing projection and thereby eliminating any jamming that might otherwise occur.

With reference now to FIG. 5, it may be desirable to facilitate optimum relation between the collar structures of the large tubing string and the body portion of the tubing retrieval mechanism, to provide a body portion 54 that differs from the body structure 22 only in the design of the tubing guide channel or recess. As shown in FIG. 5, a recess 56 is defined by generally parallel surfaces 58 and 60 that intersect a semi-cylindrical surface 62 having a radius slightly larger than the radius of the collars of the larger tubing. This particular structural configuration allows the body structure to be shifted laterally into receiving engagement about the large tubing string and lowered into the casing without necessitating the moving of the channel about the large tubing which is necessary upon utilization of the body structure 22 shown in FIGS. 1-3.

FIG. 6 depicts a body structure 64 having a fish receiving channel or bore 66 formed therein for receiving the upper extremity of a section of broken tubing string located within the well. Also provided in the body structure 64 is a pair of tubing guide channels 68 and 70 that provide for utilization of the tubing retrieval mechanism in conjunction with a triple completion well. Other structural features of the body portions 54 and 64 of the structures illustrated in FIGS. 5 and 6 respectively may conveniently take the general form illustrated in FIG. 4 with exception of the location and size of the tubing guide channels. Moreover, it is considered obvious that the body structure 64 set forth in FIG. 6 may be modified by providing parallel tubing entry surfaces such as shown at 58 and 60 in FIG. 5, thereby allowing simple lateral insertion of tubing into receiving relationship with the body structure of the tubing retrieval mechanism.

In view of the foregoing it is apparent that I have provided a tubing retrieval mechanism that is of simple design and yet is very reliable and effective for locating and establishing connection with sections of broken tubing string located within well bores. The present invention provides a mechanism having external and internal configurations that accomplish cooperative guiding function between the well casing into which it is inserted and the unbroken tubing within the well casing for establishing location of the tubing retrieval mechanism in conjunction with sections of broken tubing within the well casing. A tubing retrieval mechanism constructed in accordance with the present invention functions simply and reliably thereby allowing multiple completion wells to be effectively serviced without expensive and time consuming servicing operations occasioned by breakage of tubing within wells.

It is therefore understood that my invention is one well adapted to attain all of the objects and advantages hereinabove set forth together with other advantages which will become obvious and inherent from the description of the apparatus itself. It will be understood that certain combinations and subcombinations are of utility and may be employed without reference to other
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features and subcombinations. This is contemplated by and is within the scope of the present invention.

Although only representative embodiments of the invention have been described and shown, it is intended that numerous modifications may be made possible by one skilled in the art without departing from the spirit or scope of the present invention. It is to be further understood that the embodiments described and illustrated herein are merely illustrative of an application of the principles of the invention and that numerous other arrangement and modifications may be made in the structures illustrated without departing from the spirit and scope of this invention.

Having thus fully described my invention, I claim:

1. A spear guide mechanism for establishing connection with a separated tubing string within a well having a casing and having a plurality of tubing strings disposed within said casing for production of well fluid from a plurality of production zones, said spear guide mechanism comprising:

- a tubing retrieval element adapted to be lowered into said casing;
- means for raising and lowering said tubing retrieval element relative to said casing;
- guide means adapted to position said tubing retrieval element within said casing and being received in guided engagement by an unseparated tubing string within said well;
- separated tubing locating means being defined by said tubing retrieval element and being positioned for receiving said separated tubing string by guided co-engagement of said guide means and said unseparated tubing string; and
- spear means being carried by said tubing retrieval element and being disposed in oriented relation with said separated tubing locating means, said spear means moving into secured relation with said separated tubing string upon movement of said separated tubing locating means into receiving relation with said separated tubing.

2. A spear guide mechanism as recited in claim 1, including:

- guide means being formed at the lower extremity of said tubing retrieval element and guiding said tubing retrieval element into proper rotative position for receiving said separated tubing into said separated tubing locating means.

3. A spear guide mechanism as recited in claim 1, wherein said guide means comprises:

- elongated slot means formed in said tubing retrieval element in position for receiving said unseparated tubing therein, said elongated slot means being of sufficient dimension to allow passage of the collars of said unseparated tubing therethrough.

4. A spear guide mechanism as recited in claim 1, wherein said separated tubing locating means comprises:

- elongated guide channel means being formed in said tubing retrieval element and being disposed in generally parallel relation with said first guide means; and
- cam surface means being defined at the lower portion of said elongated guide channel means and being operative to cam said tubing retrieval element into position for receiving said separated tubing within said elongated guide channel means.

5. A spear guide mechanism as recited in claim 1, wherein:

- said guide means is an elongated passage defined by said tubing retrieval element and having the general cross-sectional configuration of said unseparated tubing, said guide means being of a size to allow passage of the collars of said unseparated tubing therethrough;
- said separated tubing locating means comprises an elongated guide channel being disposed in generally parallel relation with said elongated passage and being of a size to receive the separated tubing in close fitting relation therein; and
- said spear means is located within said elongated guide channel and is operative to become inserted within said separated tubing upon receipt of said separated tubing within said elongated guide channel.

6. A spear guide mechanism as recited in claim 5, wherein:

- said tubing retrieval element is of generally cylindrical cross-sectional configuration and is movably received in close fitting relation within said casing; and
- said elongated passage and said elongated guide channel generally conform respectively, to the cross-sectional configuration and size of the collars of said unseparated tubing and to the outer diameter of said separated tubing.

7. A spear guide mechanism as recited in claim 5, wherein said tubing retrieval element includes:

- internal shoulder means being defined at the upper portion of said elongated guide channel; and
- said spear means being disposed in supported engagement with said shoulder means and being manipulated for gripping engagement within said separated tubing upon movement of said shoulder means into forcible engagement with the upper extremity of said separated tubing upon full movement of said spear guide mechanism into receiving relation with said separated tubing.

8. A spear guide mechanism as recited in claim 7, wherein said internal shoulder means includes:

- a downwardly facing shoulder being defined by said tubing retrieval element, said shoulder being located at the upper extremity of said elongated guide channel; and
- an upwardly facing shoulder being defined by said spear means and establishing supported engagement with said downwardly facing shoulder of tubing retrieval element as said spear means is raised following connection thereof with said separated tubing.

9. A spear guide mechanism as recited in claim 8, including:

- guide means being formed at the upper portion of said tubing retrieval element and preventing hanging of said tubing retrieval element on any internal obstruction of said casing as said tubing retrieval element is withdrawn from said casing after having become connected with said separated tubing.

10. A spear guide mechanism for establishing connection with a separated tubing string within a well having a well casing and having a plurality of tubing strings within said casing for production of the well from a plurality of production zones, said spear guide mechanism comprising:
a tubing retrieval element of generally cylindrical cross-sectional configuration and being of slightly smaller external dimension than the internal dimension of said casing;

first guide channel means being formed within said tubing retrieval element corresponding to the location of unseparated tubing strings within said casing, said first guide channel means being slightly larger than the connection collars of said unseparated tubing strings;

second guide channel means being formed within said tubing retrieval element in generally parallel relation with said first guide channel means and corresponding to the location of said separated tubing string relative to said unseparated tubing strings and said casing;

cam means being formed on said tubing retrieval element and, upon engagement thereof with the upper extremity of said separated tubing string, causing movement of said tubing retrieval element into position for receiving said upper extremity of said separated tubing string therein;

spear means being disposed within said second guide channel means and being inserted into said separated tubing string upon movement of said tubing retrieval element into full receiving relation with said separated tubing string; and

means for manipulating said spear means to cause gripping engagement of said separated tubing string.

11. A spear guide mechanism as recited in claim 10, wherein said first guide channel means comprises:

at least one elongated slot extending through said tubing retrieval element, said elongated slot being offset relative to the axis of said casing and being oriented to receive said unseparated tubing strings.

12. A spear guide mechanism as recited in claim 11, wherein:

said elongated slot is of generally cylindrical cross-sectional configuration.

13. A spear guide mechanism as recited in claim 11, wherein said spear means includes:

downwardly facing internal shoulder means being defined at the upper portion of said spear means and moving into spear manipulating engagement with the upper extremity of said separated tubing string upon movement of said spear guide mechanism into full receiving relation with said separated tubing string and causing said spear means to establish gripping engagement with the internal surface of said separated tubing string.

14. A spear guide mechanism as recited in claim 13, wherein:

said tubing retrieval element includes a downwardly facing shoulder being defined by an elongated element, said shoulder being located at the upper extremity of said second guide channel means; and

said spear means includes an upwardly facing shoulder establishing supported engagement with said downwardly facing shoulder of said tubing retrieval element as said spear means is raised following connection thereof with said separated tubing.

15. A spear guide mechanism as recited in claim 14, wherein said mechanism includes:

guide means being formed at the upper portion of said tubing retrieval element and preventing hanging of said tubing retrieval element on any internal obstruction of said casing as said tubing retrieval element is withdrawn from said casing after having become connected with said separated tubing string.