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|--|-----------|---------|--------------|----------|
| [54] METHOD OF AND APPARATUS FOR POSITIONING AND CORRELATING THE END OF REMEDIAL TUBING IN RELATION TO THE LOWER END OF PRODUCTION TUBING IN A SUBTERRANEAN WELL | 2,960,165 | 11/1960 | Schramm..... | 166/255  |
|  | 3,177,941 | 4/1965  | Conrad.....  | 166/64   |
|  | 3,468,373 | 9/1969  | Smith.....   | 166/55.8 |
|  | 3,696,865 | 10/1972 | Chapman..... | 166/44   |

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[22] Filed: Mar. 25, 1974

[57] ABSTRACT

[21] Appl. No.: 454,376

[52] U.S. Cl. .... 166/255; 166/113; 166/237

[51] Int. Cl.<sup>2</sup> ..... E21B 43/00

[58] Field of Search ..... 166/250, 255, 64, 237, 166/277, 212, 55.8, 113, 315

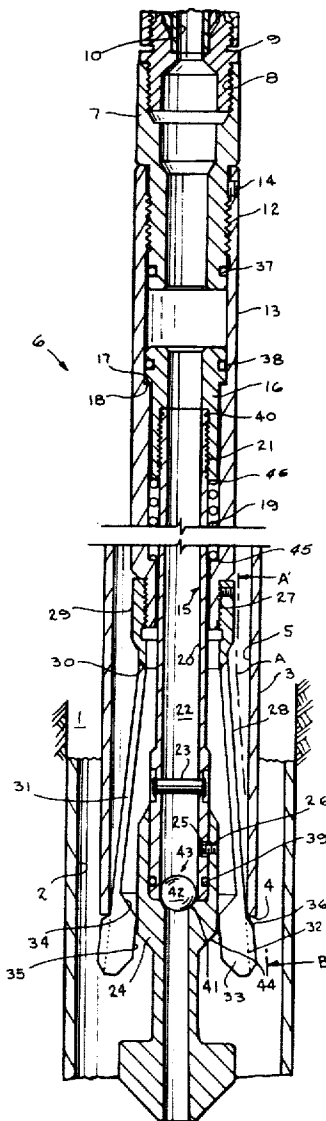
A method of and apparatus for positioning and correlating the location of the end of remedial operation tubing in relation to the lower end of production tubing in a subterranean oil or gas well, whereby locating means are hydraulically activated to contact the end of said production tubing causing interference with subsequent upper movement of the apparatus.

[56] References Cited

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32 Claims, 3 Drawing Figures

2,350,973 6/1944 Brumleu et al. .... 166/212 X



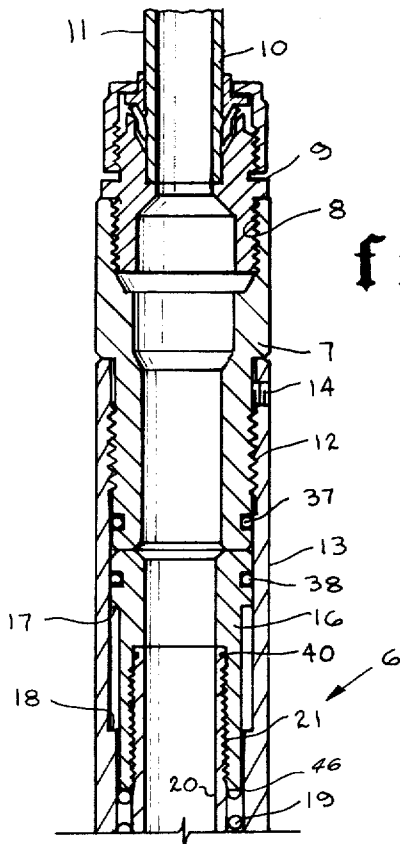


fig.1

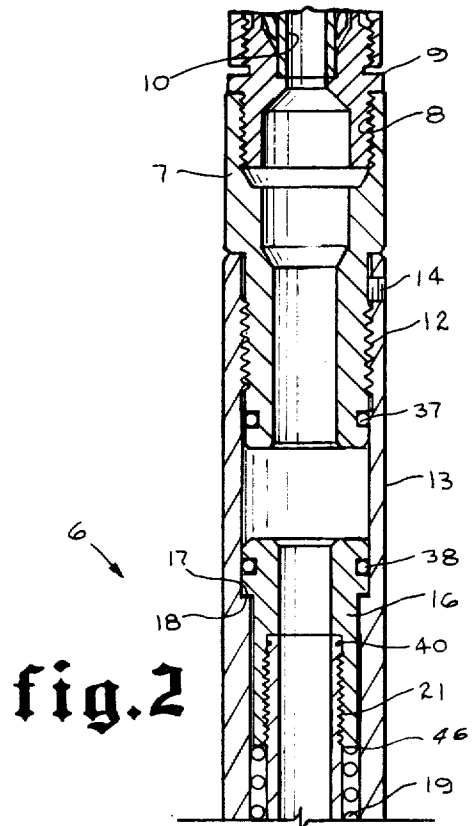
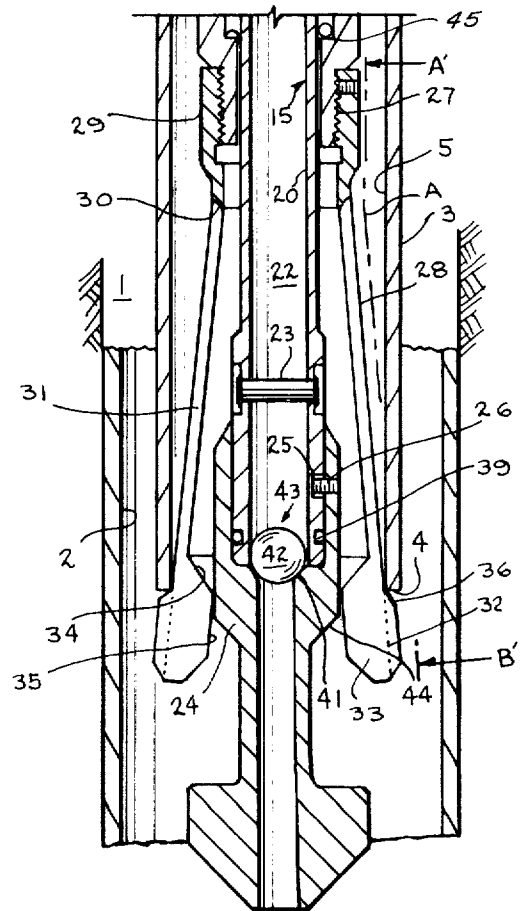
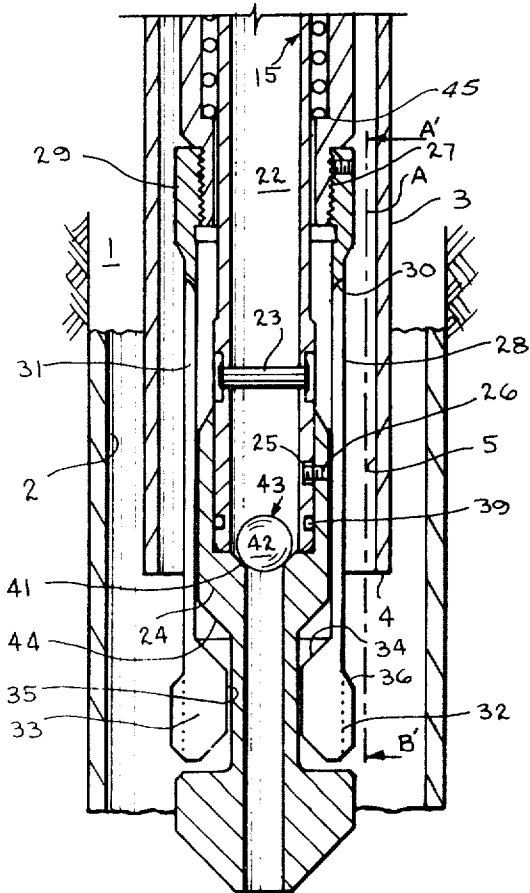
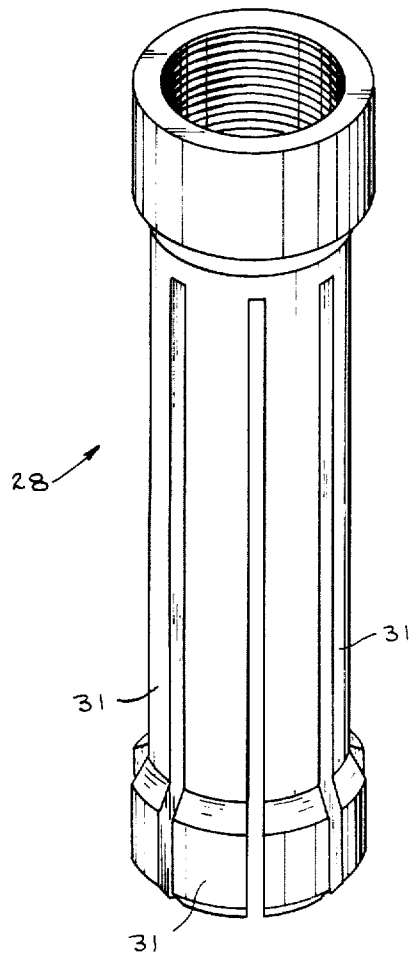


fig.2





**fig. 3**

**METHOD OF AND APPARATUS FOR  
POSITIONING AND CORRELATING THE END OF  
REMEDIAL TUBING IN RELATION TO THE  
LOWER END OF PRODUCTION TUBING IN A  
SUBTERRANEAN WELL**

**BACKGROUND OF THE INVENTION**

**1. Field of the Invention**

The present invention relates to the use of remedial operation tubing within the subterranean oil or gas well production tubing for the purpose of forcing therein fluids for the performance of well remedial, production and completion operations. More particularly, the invention relates to a method of and apparatus for correlating the lower end of said remedial tubing in relation to the lower end of the production tubing encompassing same and thereafter positioning the lower end of the remedial tubing.

**2. Description of the Prior Art**

In the past, those skilled in the art relating to remedial operations associated with the production and completion of subterranean oil and gas wells have relied on conventional "snubbing" or hydraulic workover units which utilize threaded or coupled remedial tubing normally inserted through production tubing for use in operations such as perforating, acidizing and fracturing, corrosion control, pressure testing of tubular goods and vessels, cementing, cleanout operations, sand bridge removal, storm valve recovery, insertion of kill strings, wire line tool fishing, and the like.

In recent years, continuous coiled remedial tubing and injectors for use therewith have contributed substantially to alleviating many of the disadvantages normally associated with conventional remedial tubing operations. For example, coiled tubing, being continuous, can be inserted into the well faster than threaded and coupled tubing which is furnished in relatively short sections that must be screwed together. In addition, it is easier, when required, to pass continuous tubing through stuffing boxes and blow out preventers because its exterior diameter is consistently the same size and not interrupted periodically by couplings. The coiled remedial tubing normally is made of steel and is available in sizes from ½ inch O.D. through 1.315 inch O.D., but may have a smaller or larger diameter.

Typical of such remedial tubing and injectors are those described in the 1973 *Composite Catalog of Oil Field Equipment and Services*, at page 662, (Gulf Publishing Co., Houston, Texas), and manufactured by Bowen Tools, Inc., of Houston, Texas. This type of injector apparatus is generally described in U.S. Pat. No. 3,182,877. This apparatus is commercially referred to as the "Bowen Continuous String Tubing Injector Unit" and basically comprises a hydraulically powered injector unit which feeds a continuous remedial tubing string from a coiled or "spooled" work string contained on a powered and generally portable reel unit into the well head by means of two opposed, endless, rotating traction members. Such a reel unit is generally described in U.S. Pat. No. 3,614,019. The upper end of the string which remains on the reel is conventionally connected to the hollow shaft of the reel which permits a liquid or gas to be pumped through the coiled remedial tubing string by means of a swivel connection. The injector and reel are normally mounted on a single transportable skid, a trailer, or, alternatively may be

componently arranged on skids to facilitate convenient off-shore use.

To inject remedial tubing, the injector unit is arranged on or above the well head. The reel unit, containing up to approximately 15,000 feet of continuous coiled metal remedial tubing, is located preferably about 15 to 20 feet from the well head. The coiled remedial tubing is brought from the reel in a smooth arc loop through the injector unit and into the well through pressure retention and control equipment.

Although the present invention has been primarily designed for utilization with the injector and remedial tubing as described above, it should be understood that the apparatus and method disclosed and claimed herein are not to be limited to use with this injector and remedial tubing in view of the fact that the particular remedial tubing injector unit or system does not comprise a part of the present invention. Any injector and/or remedial tubing which is compatible with the locator apparatus described herein may be utilized. For example, the present locator apparatus can be used with the conventional threaded remedial tubing forming a "string".

Normally, the remedial tubing injector system as described above will have located at the surface near the well head an odometer or similar mechanical means for continuously or incrementally measuring the length of remedial tubing inserted at the well head and through the production tubing utilized in the down hole operation. When coupled tubing is used, a measuring tape will serve the same function as an odometer. Such an apparatus or device is desirable in order to ascertain the remedial tubing lower end location in relation to the depth of production zone perforations, sand bridges and the like, so that acidizing, cementing, fishing and related operations are properly initiated. These conventional locating methods have been commonly practiced by those skilled in the art but have been found to have several disadvantages. Of particular importance is the fact that such surface-located devices have insufficient accuracy so that in many instances the lower end of the remedial tubing actually is located at a depth and distance considerably above or below that indicated by the surface device, resulting in the subsurface remedial operation being initiated at a point above or below that which is indicated by the surface device.

In view of the fact that the location of the production tubing end and the depth of the perforations or other objects or positions is known or can be easily ascertained, the particular object or position in relation to the lower remedial tubing end can be ascertained if the lower end of the remedial tubing can be correlated to the production tubing end. The remedial tubing end is then positioned at the ascertained depth of the perforations or the like.

It is, therefore, an object of the present invention to provide a method for correlating the lower end of the remedial tubing to the lower end of production tubing within a subterranean oil or gas well by utilization of a hydraulically activated apparatus affixed to the lower end of said remedial tubing.

It is a further object of this invention to provide a hydraulically activated apparatus for correlating the lower end of remedial tubing with the end of production tubing within a subterranean oil or gas well.

It is also an object of the present invention to provide, in a subterranean well having production tubing

inserted therein, a method for positioning the lower end of remedial tubing at a pre-determined depth.

Other objects and advantages of the present invention will be readily apparent from a reading of the FIGS., the specification below, and the claims.

#### SUMMARY OF THE INVENTION

The invention provides a method and apparatus for correlating the lower end of remedial tubing and the lower end of subterranean well production tubing and thereafter positioning said remedial tubing end. At the well surface, a locating apparatus is conventionally attached to the remedial tubing. The apparatus, which is hydraulically activated, has locating means which may be urged outwardly by downward movement of a hydraulically activated member. The locating means are preferably flexible "fingers" having an external abutting enlargement on the lower portion thereof for subsequent interference with the production tubing end. The apparatus also has means for retracting the locating means, which retracting means preferably may be an expandable pre-loaded spring within the hydraulically activated member to urge said member upwardly to its approximate initial position after completion of the location method, or may be a shearably removable member attached to the lower end of the hydraulically activated member. The shearably removable member also is hydraulically activated. The hydraulically activated member comprises a lower member which is preferably affixed thereto by a releasable means, such as a shear screw, or the like.

After attachment of the apparatus, the remedial tubing is lowered into the well production tubing to a point at least beyond the lower end of the production tubing. The apparatus is then activated by transmission of fluid pressure through the remedial tubing to the hydraulically activated member to outwardly extend the locating means.

After the locating means are extended, the remedial tubing is raised until the locating means contact the lower end of the production tubing, thereby causing interference with continued upward movement of the remedial tubing and apparatus. This point is easily ascertainable at the surface by a variation on the remedial tubing weight indicator or similar surface means. The corresponding position of the remedial tubing at the surface is then "flagged" by marking it with respect to a known reference point such as the well head, or merely by resetting the odometer to reflect the known depth at which the end of tubing is now located. By "flagging" is meant to refer to any method which can be utilized to note at the well surface the position, in relation to a known reference point, of the lower end of the remedial tubing at the point indicated by use of the locator apparatus. The particular method of flagging is not critical to the invention.

Subsequent to the flagging step, the locating means are retracted. If initiation of the remedial operation is desirable, the pressure within the remedial tubing and the apparatus is increased to a point which will release the disengageable lower member thereby causing retraction of the locating means and opening the end of the apparatus to permit free circulation of fluid there-through. Alternatively, the pressure can be decreased so that the pre-loaded spring will expand and cause the locating means to retract to the position in the initial

mode. The remedial tubing can then be moved within the production tubing if so desired.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section drawing of the apparatus in a retracted or initial mode.

FIG. 2 is a similar drawing showing the apparatus in the operating or locating mode.

FIG. 3 is a drawing along line A of FIG. 1 from points A' to B' showing a circular shaped collet member and locating means with an external abutting enlargement, which comprise the lower flexible portion of the collet.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, showing the preferred apparatus in a retracted or initial mode within well bore hole 1 having casing wall 2 and being located within well production tubing 3 having open end 4 and side 5, the locator apparatus 6 has a top member 7 which is normally a substitute (hereinafter referred to as a "sub") having tapered self-sealing female threads 8 for initial connection of the apparatus 6 to a connector 9 which is affixed to the lower end 10 of remedial tubing 11 by conventional means. Top sub 7 is connected by threads 12 to tubular housing 13. Preferably, a set screw 14 is provided at the top of tubular housing 13 to lock the threads connecting top sub 7 and tubular housing 13. Tubular member 15 is telescopically positioned within tubular housing 13 and comprises spring retainer 16, mandrel 20, and ball seat 24. Mandrel 20 is attached at its upper end to spring retainer 16 by threads 21 and is attached at its lower end to ball seat 24 by shear screw 26. Spring 19, mounted around mandrel 20 abuts at its lower end on shoulder 45 of tubular housing 13 and its upper end on end 46 of spring retainer 16, and serves to urge tubular member 15 upwards until limited by contact of the upper end of spring retainer 16 and the lower end of top sub 7. Fluid transporting passage 22 is located within tubular member 15. Mandrel 20 has affixed thereto at the lower portion thereof a pin 23, which passes through fluid transporting passage 22. Ball seat 24 is affixed to mandrel 20 at point 25 by shear screw 26.

Threads 27 on the lower portion of tubular housing 13 serve as a means of connecting the locating means, preferably comprising a collet 28 having an upper cylindrical portion 29, finger 31 formed by slots ending at point 30 with lower external abutment 32 on spoon 33, and surfaces 34, 35 and 36. O-rings 37, 38, 39 and 40 provide seals in their respective positions to prevent escape of fluid within the locator apparatus 6.

Ball seat 24 has surface 41 which will sealably engage ball 42 at position 43 and will act as a check valve to prevent fluid passage downward through the locator apparatus 6. Ball seat 24 also has surface 44 which, upon activation of locator apparatus 6 causing downward movement of tubular member 15 in relation to the stable position of tubular housing 13, ultimately will contact surface 34 on spoon 33 to urge finger 31 outwardly, eventually resulting in lower external abutment 32 being extended at least slightly beyond production tubing side 5. Ball 42 is prevented from moving upwardly, except to a limited extent, from the lower portion of mandrel 20 by pin 23.

FIG. 2 illustrates locator apparatus 6 in the locating or operating mode. In this mode, tubular member 15

has been forced downward with respect to the outer portion of the apparatus by pressure applied internally to the remedial tubing until limited by contact between shoulder 18 inside tubular housing 13 and shoulder 17 on spring retainer 16. As tubular member 15 is hydraulically urged downward, spring 19 is compressed and surface 44 on ball seat 24 contacts surface 34 on finger 31 to urge finger 31 outwardly. Ball seat surface 44 eventually will slide under finger surface 35, as the result of the downward travel of tubular member 15 and the stable position of tubular housing 13, to retain finger 31 in an outward position.

For proper operation of locator apparatus 6, it is necessary that locator apparatus 6 be beyond the lower end 4 of the production tubing 3 to permit finger 31 to flex and allow lower external abutment 32 to extend at least slightly beyond production tubing side 5 at open end 4 so that interference with the upward travel of the locator apparatus 6 will be caused by the contact of surface 36 and production tubing side 5. The upward travel interference is easily determined at the well surface by a variation in weight on the remedial tubing. If the apparatus 6 is activated within production tubing 3, upper travel interference will not occur and it will be known that the apparatus has been prematurely activated. The locating means then are retracted by reducing the hydraulic pressure which will permit spring 19 to expand and urge tubular member 15 to its original position with respect to tubular housing 13. Another attempt to locate the end of the production tubing can then be made by lowering the remedial tubing 11 a short distance and re-activating the apparatus.

FIG. 3 illustrates collet 28 as shown in FIG. 1. The actual number of locating means, such as finger 31, is not critical to the practice of the invention. The apparatus depicted in FIGS. 1 and 2 contains the preferred number of 6. However, a smaller number or a larger number could easily be substituted therefor.

Finger 31 may have means other than lower external abutment 32 which will permit travel interference with locator apparatus 6. The exact formation and structure of spoon 33 and lower external abutment 32 are not critical to the invention, and, accordingly, the number and shape of surfaces on spoon 33 and/or lower external abutment 32 can be varied to accommodate alternative embodiments.

#### OPERATION OF THE METHOD AND APPARATUS

As remedial tubing 11 is lowered in production tubing 3, a mechanical or measuring device, located in the vicinity of the well surface, such as an odometer (not shown in the FIGS.), will ultimately indicate that the locator apparatus 6 generally has at least passed beyond production tubing open end 4. A nominal increase in pressure of about 200 p.s.i. (pounds per square inch) over that required for hydrostatic equilibrium within remedial tubing 11, which is generated by forcing a fluid into remedial tubing 11, by use of pumping means or the like located at the well surface, and which is contained within locator apparatus 6 by solid ball 42 in position, forces tubular member 15 to move downwardly in relation to tubular housing 13, and compress spring 19. As tubular member 15 moves downwardly in relation to the stable position of tubular housing 13, surface 44 on ball seat 24 moves toward surface 34 on slotted finger 31. As additional hydraulic force is applied within tubing 11, tubular member 15 will

continue to be forced downwardly with respect to open housing 13.

With the locator apparatus 6 in the open or operating mode, surface 36 on spoon 33 is caused to contact well production tubing side 5 at open end 4 by raising remedial tubing 11 at the surface until surface 36 contacts tubing end 4 such that interference is caused with the subsequent upward movement of remedial tubing 11. The remedial tubing 11 is then flagged at the surface of well bore hole 1 to indicate the exact location of production tubing open end 4 found by locator apparatus 6. The end of the remedial tubing 10 can subsequently be moved an accurately measured relatively short distance to the predetermined depth to begin the remedial operation.

Prior to initiating remedial action and with the locator apparatus at or below the end of the production tubing, pressure within remedial tubing 11 is increased sufficiently to break shear screw 26 at point 25, thus disengaging ball seat 24 and causing ball seat 24 as well as ball 42 to free fall to the bottom of well bore hole 1. Under normal operating conditions, the amount of pressure necessary will be approximately 1,000 p.s.i. The removal of ball seat 24 and ball 42 thus will open the end of apparatus 6 to permit circulation of fluid for the remedial operation. Concurrently, as ball seat 24 is disengaged, finger 31 will return to the retracted or initial position to allow the remedial tubing to be moved within the production tubing. Thereafter, locator apparatus 6 may be moved within or below production tubing 3 to the desired position for the remedial operation. The disengagement of ball seat 24 will be readily apparent at the surface by an indication of fluid flow.

Reverse circulation of fluid in the well bore through the locator apparatus and remedial tubing to the surface of the well, if such is necessary or desirable, may be accomplished at any time.

Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by way of illustration only and that the invention is not necessarily limited thereto, since alternative embodiments and operating techniques will become apparent to those skilled in the art in view of the disclosure. Accordingly, modifications are contemplated which can be made without departing from the spirit of the described invention.

I claim:

1. In a subterranean well, a method for correlating the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising the steps of:

A. Affixing to the lower end of the remedial tubing an apparatus having:

1. A hydraulically activated member;
2. Locating means which may be urged outwardly by downward movement of the hydraulically activated member; and
3. Means for retracting the locating means;

B. Lowering the apparatus affixed to the remedial tubing into the production tubing in the well to a point at least lower than the lower end of the production tubing;

C. Activating the apparatus by applying fluid pressure through the remedial tubing to the hydraulically activated member to outwardly extend the locating means;

D. Raising the remedial tubing to a point whereby the extended locating means contact the lower end of the production tubing and cause interference with continued upward travel of the remedial tubing;

E. Flagging at the subterranean well surface the interference point determined by Step D.

2. The method of claim 1 wherein the hydraulically activated member has affixed thereon a removable lower member.

3. The method of claim 1 wherein the hydraulically activated member comprises a removable lower member shearably affixed thereto.

4. The method of claim 1 wherein said locating means are the lower flexible fingers of a collet member of said apparatus.

5. The method of claim 1 wherein the means for retracting the locating means comprises an expandable spring within said hydraulically activated member.

6. The method of claim 1 wherein the means for retracting the locating means comprises a removable member attached to the lower end of said hydraulically activated member.

7. The method of claim 1 wherein the remedial tubing is pre-coiled metallic tubing.

8. In a subterranean well, a method for correlating the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising the steps of:

A. Inserting remedial tubing into the well through the production tubing, the remedial tubing having attached to the lowered end thereof an apparatus having:

1. A hydraulically activated member;
2. Locating means which may be urged outwardly by downward movement of the hydraulically activated member; and
3. Means for retracting the locating means;

B. Lowering said apparatus attached to the remedial tubing through the production tubing in the well to a point at least beyond the lower end of the production tubing;

C. Activating the apparatus by applying fluid pressure through the remedial tubing to the hydraulically activated member to outwardly extend the locating means;

D. Raising the remedial tubing to a point whereby the extended locating means contact the lower end of the production tubing and cause interference with continued upward travel of the remedial tubing; and

E. Flagging at the subterranean well surface the interference point determined by Step D.

9. The method of claim 8 wherein the hydraulically activated member has affixed thereon a removable lower member.

10. The method of claim 8 wherein the hydraulically activated member comprises a removable lower member shearably affixed thereto.

11. The method of claim 8 wherein said locating means are the lower flexible fingers of a collet member of said apparatus.

12. The method of claim 8 wherein the means for retracting the locating means comprises an expandable spring within said hydraulically activated member.

13. The member of claim 8 wherein the means for retracting the locating means comprises a removable

member attached to the lower end of said hydraulically activated member.

14. The method of claim 8 wherein the remedial tubing is precoiled metallic tubing.

15. In a subterranean well having production tubing inserted therein, a method for positioning the lower end of remedial tubing at a predetermined depth, comprising steps of:

A. Correlating the lower end of production tubing and the lower end of remedial tubing inserted therein by:

1. Affixing to the lower end of the remedial tubing an apparatus having:

- A. A hydraulically activated member;
- B. Locating means which may be urged outwardly by downward movement of the hydraulically activated member; and
- C. Means for retracting the locating means;

2. Lowering the apparatus affixed to the remedial tubing into the production tubing in the well to a point at least lower than the lower end of the production tubing;

3. Activating the apparatus by applying fluid pressure through the remedial tubing to the hydraulically activated member to outwardly extend the locating means;

4. Raising the remedial tubing to a point whereby the extended locating means contact the lower end of the production tubing and cause interference with continued upward travel of the remedial tubing;

5. Flagging at the subterranean well surface the interference point determined by "4" above;

B. Retracting the locating means; and

C. Moving the remedial tubing to the predetermined depth.

16. The method of claim 15 wherein the hydraulically activated member has affixed thereon a removable lower member.

17. The method of claim 15 wherein the hydraulically activated member comprises a removable lower member shearably affixed thereto.

18. The method of claim 15 wherein said locating means are the lower flexible fingers of a collet member of said apparatus.

19. The method of claim 15 wherein the means for retracting the locating means comprises an expandable spring within said hydraulically activated member.

20. The method of claim 15 wherein the means for retracting the locating means comprises a removable member attached to the lower end of said hydraulically activated member.

21. The method of claim 15 wherein the remedial tubing is pre-coiled metallic tubing.

22. An apparatus for correlation in a subterranean well of the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising: (a) a hydraulically activatable member for initiating correlation; (b) means for locating said lower end of said production tubing, said means being urgeable outwardly by downward movement of the hydraulically activatable member; and (c) means for retracting the locating means upon correlation of said lower tubing ends.

23. The apparatus of claim 22 wherein the hydraulically activatable member has affixed thereto a removable lower member.

24. The apparatus of claim 22 wherein the hydraulically activatable member has affixed thereto a sheara- bly removable lower member.

25. The apparatus of claim 22 wherein said locating means are the lower flexible fingers of a collet member of said apparatus.

26. The apparatus of claim 22 wherein the means for retracting the locating means comprises an expandable spring within said hydraulically activated member.

27. The apparatus of claim 22 wherein the means for retracting the locating means comprises a member selectively detachable from said apparatus and attached to the lower end of said hydraulically activatable member.

28. In an apparatus for positioning in a subterranean well having production tubing inserted therein, the lower end of remedial tubing at a predetermined depth by correlation of the lower end of the production tubing and the lower end of the remedial tubing, the improvement which comprises: (a) a hydraulically activatable member for initiating correlation; (b) means for locating said lower end of said production tubing, said means being urgeable outwardly by downward movement of the hydraulically activatable member; and (c) means for retracting the locating means upon correlation of said lower tubing ends.

29. In a subterranean well, a method for correlating the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising the steps of:

- A. Affixing to the lower end of the remedial tubing an apparatus having:
  - 1. an actuating member;
  - 2. locating means engageable by said member and which may be urged outwardly by downward movement of said member; and
  - 3. means for retracting the locating means;
- B. Lowering the apparatus affixed to the remedial tubing into the production tubing in the well to a point at least lower than the lower end of the production tubing;
- C. Activating the apparatus by moving the activating member downwardly to outwardly extend the locating means;
- D. Raising the remedial tubing to a point whereby the extended locating means contact the lower end of the production tubing and cause interference with continued upward travel of the remedial tubing; and
- E. Flagging at the subterranean well surface the interference point determined by Step D.

30. An apparatus for correlation in a subterranean well of the lower end of production tubing and the lower end of remedial tubing inserted therein, compris-

ing: (a) a hydraulically activatable member for initiating correlation; (b) means for locating said lower end of said production tubing and which may be expanded outwardly by downward movement of the hydraulically activatable member; and (c) said member including means disengageable from said locating means and removable from said apparatus whereby said means for locating said lower end of said production tubing is retracted from expanded position.

31. An apparatus for correlation in a subterranean well of the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising: (a) an actuating member for initiating correlation; (b) means for locating said lower end of said production tubing, said means being engageable by said member and which may be expanded outwardly by downward movement of said member; and (c) said member including means disengageable from said means for locating said lower end of said production tubing enabling said means for locating said lower end of said production tubing to be retracted from expanded position, said means disengageable from said locating means further being selectively detachable from said apparatus.

32. In a subterranean well, a method for correlating the lower end of production tubing and the lower end of remedial tubing inserted therein, comprising the steps of:

- A. Affixing to the lower end of the remedial tubing an apparatus having:
  - 1. a hydraulically activated member;
  - 2. locating means engageable by said member and which may be expanded outwardly by downward movement of the hydraulically activated member; and
  - 3. said member including means disengageable from said locating means, enabling said locating means to be retracted from expanded position.
- B. Lowering the apparatus affixed to the remedial tubing into the production tubing in the well to a point at least lower than the lower end of the production tubing;
- C. Activating the apparatus by moving the activating member downwardly to outwardly extend the locating means;
- D. Raising the remedial tubing to a point whereby the extended locating means contact the lower end of the production tubing and cause interference with continued upward travel of the remedial tubing; and
- E. Flagging at the subterranean well surface the interference point determined by Step D.

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