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Barnes

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[54] **WIRE LINE SPEAR MECHANISM**

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[52] **U.S. Cl.** **294/86.1**; 294/86.24

[51] **Int. Cl.** **E21b 31/10**

[58] **Field of Search** ..... 294/86.1, 86.11, 86.12, 294/86.14, 86.24, 86.25, 86.26, 86.28, 86.29, 86.32, 86.34; 24/263 DF; 166/99, 101, 170, 173, 174, 241

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Primary Examiner—Evon C. Blunk
Assistant Examiner—Johnny D. Cherry

[57] **ABSTRACT**

A wire line spear mechanism for application in wells wherein a wire line utilized in workover operations may have become broken and wherein a wire line spear is utilized for retrieving the broken wire line from the well. The wire line spear mechanism of the present invention may incorporate a plurality of wiper bars, disposed within longitudinal slots formed therein, which wiper bars may be urged radially outwardly from the center of the body portion of the spear mechanism into engagement with the cylindrical internal surface of the tubing within which the spear mechanism may be disposed. To prevent coils of wire line from bypassing and fouling the spear, each of the wiper bars may be provided with arcuate cam finger elements that catch the convolutions of the wire line as the retrieving spear is moved downwardly in the tubing. To facilitate utilization of the spear mechanism within a tubing string having an upper section of smaller internal diameter, the movable wiper bar assemblies carried by the wire line spear stop may incorporate cam surface means allowing the wiper bar assemblies to be cammed radially inwardly to assume sliding engagement with the internal cylindrical surface of the smaller diameter tubing.

8 Claims, 5 Drawing Figures

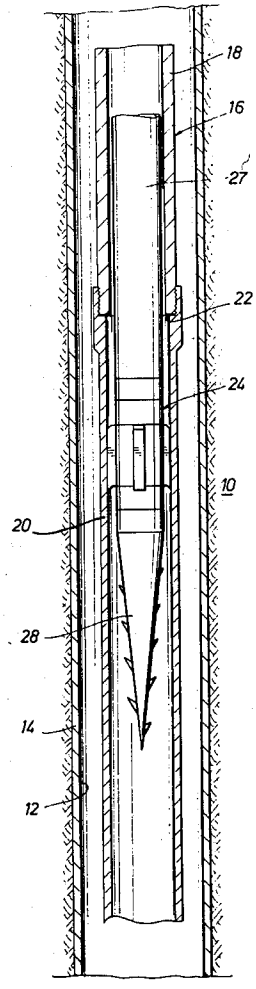


FIG. 1

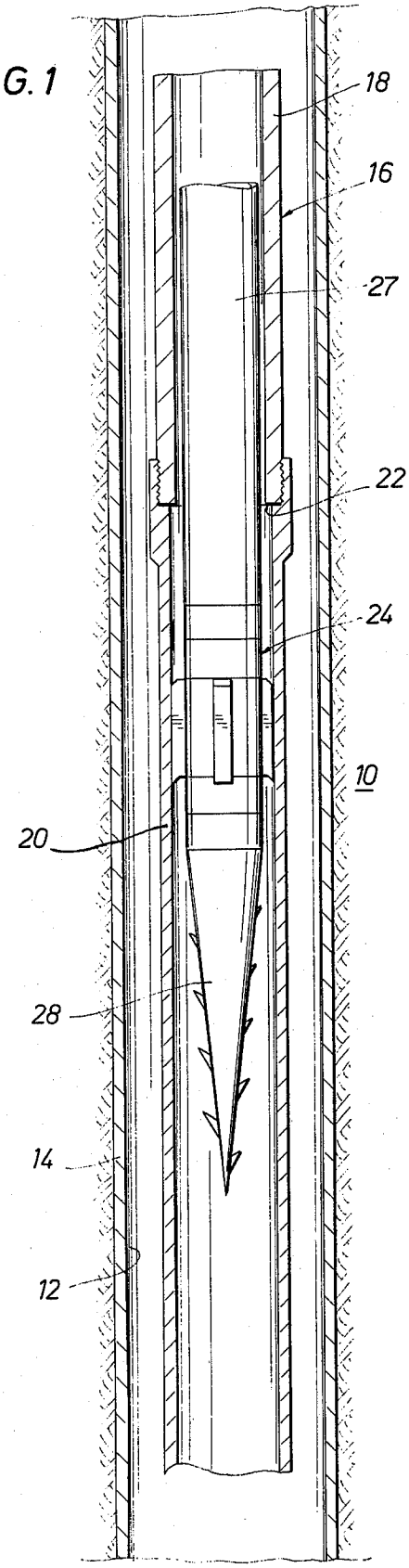
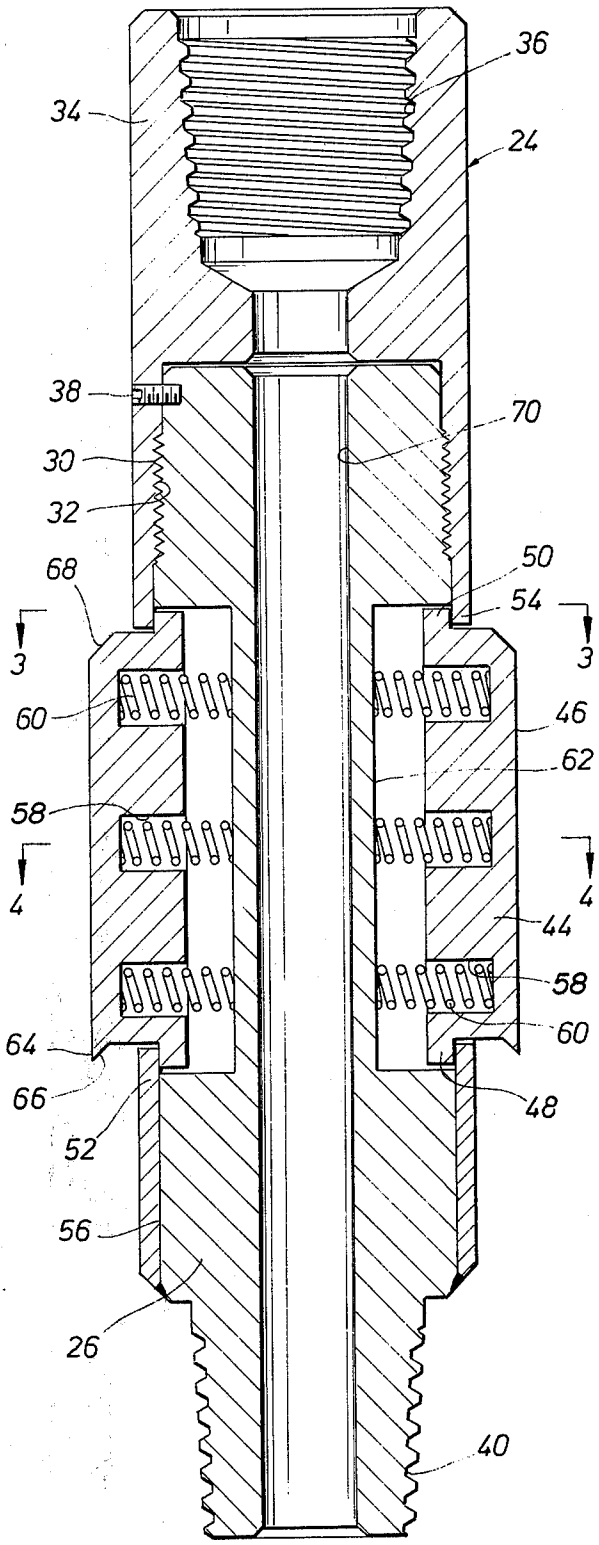

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FIG. 2


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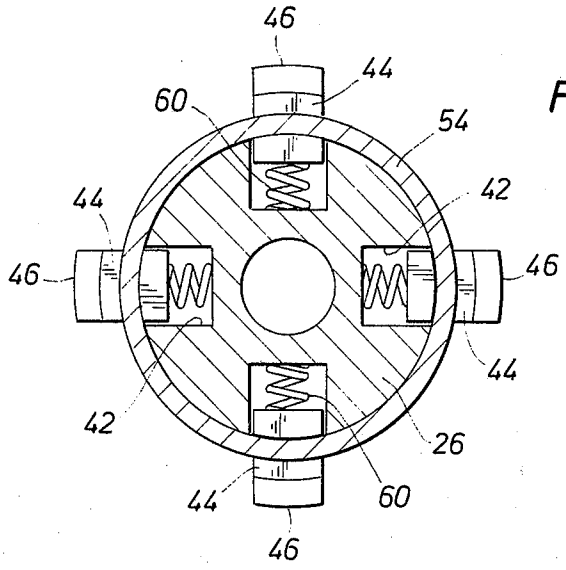


FIG. 3

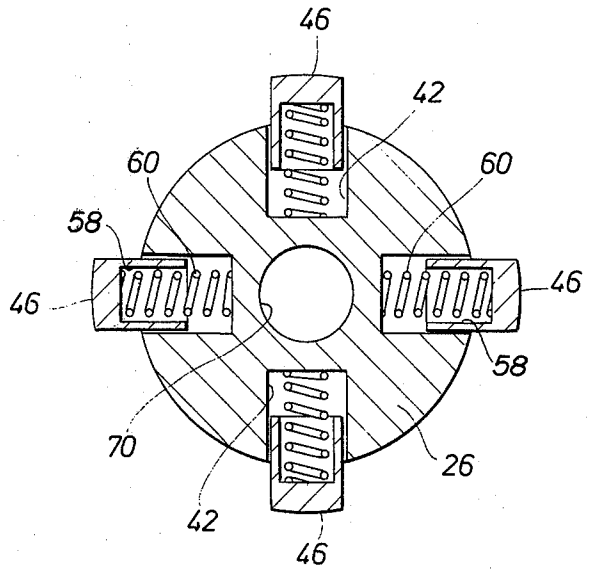


FIG. 4

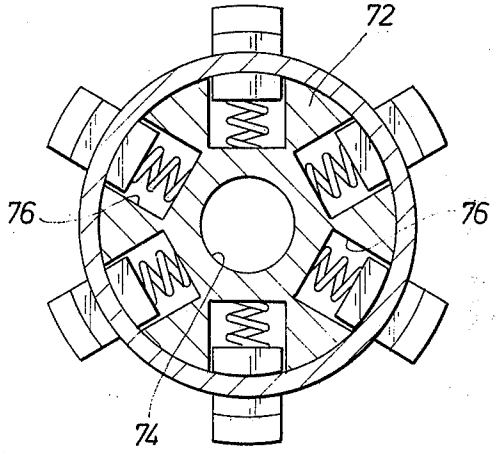


FIG. 5

WIRE LINE SPEAR MECHANISM

FIELD OF THE INVENTION

This invention is directed generally to apparatus for retrieval of broken wire lines from the production tubing of wells and more particularly is directed to the provision of means for preventing a wire line retrieval spear from becoming fouled by convolutions of the wire line as the wire line retrieval spear is reciprocated within the tubing in order to become attached to the broken wire line.

BACKGROUND OF THE INVENTION

When various well tools are employed for conducting cleaning, repair or other suitable operations in wells it is typically desirable to employ a wire line mechanism for manipulating such well tools within the well. If, for some reason, the wire line should become broken, it will be necessary to retrieve the wire line and the associated tool from the tubing string within which the wire line and the wire line tool may be disposed.

When a wire line breaks, it will typically settle to a certain extent in the tubing string forming helical convolutions. A number of devices have been developed that may be lowered into the tubing string in any desirable manner and which devices include grappling means that become entangled with several convolutions of the broken wire line and thereby enable the wire line and the tool actuated thereby to be retrieved from the wall. Such devices may commonly be referred to as wire line retrieval spears.

One problem that may be encountered utilizing a wire line spear for retrieval of a broken wire line is the fact that, while reciprocating the spear within the tubing in a grappling operation to cause several convolutions of the wire line to become entangled or locked with the spear, the entire spear may move downwardly below a number of convolutions of the wire line. As the spear is then moved upwardly withdrawing the broken wire line from the tubing, the convolutions of the wire line above the spear may interfere with upward movement of the spear within tubing.

Wire line fouling especially becomes a problem when a section of high strength tubing is utilized above a section of lower strength tubing because the high strength tubing will typically have a smaller internal diameter than the internal diameter of lower strength tubing. The external diameter of both high strength and low strength tubing will be of generally the same dimension in order to facilitate positioning of one or more tubing strings with a well casing. As the wire line spear is moved upwardly and reaches the high strength tubing string where an internal shoulder is defined by the reduced internal diameter of the high strength tubing, convolutions of the broken wire line existing above the spear may contact the shoulder and may interfere with or prevent further upward movement of the spear. It is desirable therefore to provide a suitable mechanism for positively preventing any of the convolutions of the broken wire line from moving upwardly above the spear. It is also desirable that the spear be properly oriented within the tubing to insure optimum function thereof. It is desired to provide means for providing a guiding transition function enabling the wire line retrieval spear to be properly oriented with respect to the internal diameters of the high strength and regular strength tubing that might be encountered, thus preventing any interference of the borken wire line and the wire line spear with the internal wall structure of the tubing string regardless of the internal dimension thereof.

It is therefore a principal object of the present invention to provide a novel wire line spear mechanism having means provided thereon for engagement with the internal wall structure of the tubing string regardless of the internal dimension thereof and which effectively prevents convolutions of the broken wire line from moving to a position on the spear where such convolutions might interfere with or prevent upward movement of the spear and wire line even though connected tubing sections of different internal diameters might be encountered.

It is another important object of the present invention to provide a novel wire line spear mechanism having means for positively centering the wire line retrieval spear within the tubing regardless of the internal dimension of the tubing within which the spear is disposed.

It is also an object of the present invention to provide a novel wire line spear mechanism having movable elements that are urged into contact with the internal diameter of the tubing in which the spear is disposed and which include cam means that facilitate repositioning of the movable elements to the proper position for contact with the internal surface upon encountering tubing of varying internal diameter as the spear mechanism is moved through the tubing string.

Among the several objects of the present invention is noted the contemplation of a novel wire line spear mechanism that effectively prevents convolutions of the borken wire line within the tubing string of the well from becoming bound between the spear and the wall structure of the tubing within which the spear is movably disposed.

It is also an object of the present invention to provide a novel wire line spear mechanism that is of simple construction, 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 consideration of the written specification, the appended claims and the annexed drawings. 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 take the form of a body portion that may be provided with an internally threaded upper extremity for connection thereof to a wire line spear manipulating conduit may be lowered into the tubing string for wire line retrieval operations. The body portion may have a lower externally threaded extremity adapted to be connected to the upper internally threaded extremity of a conventional wire line retrieval spear.

A plurality of elongated axially disposed slots may be formed in the body portion and may retain wiper bar elements that may be biased outwardly toward engagement with the wall structure of the tubing by urging means, such as a plurality of compression springs, for example. Each of the wiper bars may be provided with a depending finger element having an arcuate, up-

wardly and inwardly tapering cam surface defined thereon which catches convolutions of the broken wire line and moves them downwardly, preventing the spear and wire line spear stop mechanism from moving downwardly past convolutions of the broken wire line.

The movable elements are urged into engagement with the wall structure of the tubing and the movable elements change position to accommodate the particular size of tubing within which the spear stop mechanism is employed. Cam surface means may also be provided on the movable elements of the spear stop mechanism allowing the movable elements to be cammed inwardly to accommodate tubing of smaller internal diameter, as the spear mechanism is moved upwardly within the tubing string.

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 can be 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 howecer 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 partial sectional view taken through a well bore formed in an earth formation and illustrating positioning of a wire line retrieving spear mechanism, constructed in accordance with the present invention, being positioned within the regular strength portion of a tubing string and disposed immediately below the high strength portion of the tubing string.

FIG. 2 is a sectional view of the spear stop mechanism of the present invention shown to be disassembled from the spear and spear actuating conduit.

FIG. 3 is a sectional view taken along line 3—3 in FIG. 2.

FIG. 4 is a sectional view taken along line 4—4 in FIG. 2.

FIG. 5 is a sectional view of a modified embodiment of the present invention illustrating the cross-sectional design of a wire line spear stop mechanism of larger dimension as compared to the structure set forth in FIG. 4, for example.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawings and first to FIG. 1 an earth formation is illustrated at **10** within which may be formed a well bore **12** suitably lined with a well casing **14.** One or more tubing strings may be disposed within the casing **12** for communication with an oil or gas bearing production zone within the earth formation. As shown in FIG. 1 a single tubing string, illustrated generally at **16,** is employed which may incorporate a section of high strength tubing **18** that may be coupled in any suitable manner to a second of tubing **20** having characteristics of ordinary tensile strength. It is necessary for the tubing within a well to support its own length and, when deep wells are involved, it typically becomes necessary for the use of high strength tubing at the upper portion of the well in order that the weight of the tubing in the lower portion of the well may be effectively supported. The tubing within the lower portion of such wells will typically be of conventional tensile strength.

Because the casing of a well is of limited dimension it is necessary where high strength tubing is employed to reduce the internal diameter of the tubing and thereby gain a greater wall thickness rather than to increase the external dimension thereof. Where tubing of high and average tensile strength are joined, as shown in FIG. **1,** an abrupt annular shoulder will be defined, which shoulder may interfere with or prevent broken wire line from being withdrawn from a tubing string in the event convolutions of the broken wire line are disposed about and above the wire line retrieval spear. It is therefore desirable to provide a means for allowing efficient transition of a wire line spear through a tubing connection such as illustrated in FIG. **1** in such manner as to prevent the annular shoulder **22** from interfering with or preventing upward movement of the spear with the broken wire line secured thereto.

The present invention, therefore, has, as its principal object, the provision of a wire line spear stop mechanism, illustrated generally at **24,** that may be secured to the lower extremity of a spear manipulating conduit **27** that is reciprocated or rotated as desired within the tubing string to cause a wire line retrieval spear **28** connected to become sufficiently entangled with or secured to the broken wire line so that the wire line and the well tool manipulated by the wire line may be efficiently removed from the tubing string.

Referring now to FIG. **2,** the wire line spear stop mechanism **24** may incorporate a body portion **26** that may be provided with external threads **30** at one extremity thereof which may be disposed in threaded engagement with internal threads **32** defined within an adapter sub **34.** The adapter sub may be provided with an internally threaded extremity **36** that may be disposed in threaded engagement with the externally threaded portion of conventional tubing **27** that may be utilized for manipulation of the spear **28.** The adapter sub **34** may be secured against rotation relative to the body portion **26** by one or more set screws **38** retained within aligned threaded portions of the adapter sub and the body **26.**

The lower or downhole extremity of the body **26** may be provided with an externally threaded portion **40** that may be received in threaded engagement with internal threads defined within the upper extremity of the wire line retrieval spear **28,** thereby supporting the spear in rigid axially aligned relationship with the body portion **26.**

As illustrated in longitudinal section in FIG. **2** and in cross section in FIG. **3,** a plurality of elongated recesses **42** may be defined in the body portion **26,** within each of which recesses may be disposed a wiper bar **44** having a wiper surface **46** defined thereon and disposed for wiping contact with the inner peripheral wall structure of the tubing within which the wire line spear stop mechanism may be disposed. Each of the wiper bars may be provided with axial projections **48** and **50,** respectively, that may cooperate with retainer elements **52** and **54** that serve to retain the wiper bars and prevent them from becoming separated from the spear stop mechanism even when the spear stop mechanism is not disposed within a tubing string. The projections are positioned to allow considerable radial movement

of the wiper bars to allow the outer surfaces **46** thereof to move into contact with the inner wall of the tubing regardless of the physical dimension of the inner wall. Retainer element **52**, which may conveniently take the form of a sleeve closely fitting about the outer periphery **56** of the body **26**, may be welded or otherwise fixed at one extremity thereof to the body portion. The opposite retainer element **54** may define an extension of the adapter sub **34** and may be retractable upon unthreading of the adapter sub from the body **26** in order to allow the wiper bars to be removed from the recesses for repair or replacement.

A plurality of blind bores **58** may be formed in each of the wiper bars **44** and may retain compression springs **60** that collectively bear against the bottom wall **62** of the recess and urge the wiper bars radially outwardly to the extent allowed by contact between the extension elements **49** and **50** and the retainer elements **52** and **54**.

As the wire line retrieval spear mechanism is moved downwardly in the tubing and contact is made with the broken wire line disposed within the tubing it is desirable to prevent the spear mechanism from moving completely below the convolutions of wire line which might otherwise interfere with or prevent movement of the wire line spear mechanism along with the wire line through the conduit, especially those portions of the conduit that define annular shoulders and restriction because of interface between tubing sections of average and high tensile strength.

Each of the wiper bars **44** may conveniently be provided with downwardly disposed arcuate finger elements or flanges **64** having an upwardly and inwardly tapered cam surface **66** defined thereon which causes the convolutions of the broken wire line to be moved away from the wall of the tubing and forced downwardly along with the spear mechanism. The cam surface **66** urges the convolutions of the wire line radially inwardly and prevents them from slipping around the outer peripheral portion of the wire line spear mechanism. The spear mechanism may thus be reciprocated in order to achieve proper retrieving, engagement, or entanglement between the spear and the broken wire line and then the wire line may simply be retrieved along with the spear mechanism as the same is withdrawn through the tubing along with the spear manipulator conduit **27**.

As the wire line spear mechanism is moved upwardly through the tubing and an annular internal shoulder is encountered, such as will be defined by connection between sections of high strength and average strength tubing, it will be desirable to provide means for moving the wiper bar elements **44** radially inwardly to cause the same to engage the internal wall structure of the high strength tubing and conform to the reduced internal diameter thereof. It is also desirable that the wire line spear stop mechanism include means for faciliting accurate alignment of the spear moved thereby to insure proper correspondence of the spear relative to the annular internal shoulder defined by the high strength tubing.

One suitable means for accomplsihing radially inward movement of the wiper bar elements **44** against the compression of the springs **60** may conveniently take the form of a transition cam surface **68** that reacts against the annular internal shoulder **22** of the tubing and develops a force on the wiper bars moving them radially inwardly against the force of compression springs **60** to the extent necessary for allowing the spear mechanism to be moved through the small diameter high strength tubing. The cam surface **68** may conveniently take the form of a portion of a cone, thereby causing the cam surface to have line contact with the annular shoulder defined by the reduced diameter high strength tubing. This feature facilitates accurate radially inward movement of the wiper bars **44** and prevents the annular shoulder from stopping upward movement of the spear mechanism within the tubing string.

With the wire line retrieval spear connected through the spear mechanism to the spear manipulating conduit **26** it may become desirable to conduct other operations within the tubing and below the level of the spear. The body portion **26** may therefore be provided with an axial bore **70** through which such operations may conveniently be conducted.

As illustrated in FIG. **4** for certain sizes of well conduit it may be appropriate to provide a body portion **26** having four wiper bars **44** carried within appropriate elongated recesses formed therein. If the conduit is of larger dimension, it may be appropriate to provide a wire line spear stop mechanism constructed in accordance with FIG. **5** which includes a body portion **72** having a bore **74** formed therethrough and having as many as six or eight longitudinally disposed recesses **76** formed therein, each recess receiving a wiper bar mechanism constructed essentially as illustrated in FIG. **2**.

The wire line spear mechanism of the present invention effectively prevents the spear from moving downwardly below the level of the uppermost convolutions of broken wire line that might be disposed within the tubing string. The camming fingers **64** effectively displace convolutions of the wire line from the wall structure of the tubing and cam them radially inwardly, thereby causing the convolutions to be forced downwardly along with the spear stop structure and thereby allowing the spear to come into full engagement with a number of convolutions of the wire line and become positively secured thereto. As the spear and the spear stop mechanism are withdrawn from the well, the convolutions of the broken wire line will not interfere with extraction operations even when a reduced diameter shoulder is encountered such as typically results when a joint between high strength and conventional strength tubing is encountered. As the wire line stop mechanism is moved upwardly and an internal annular shoulder is encountered, the cam surfaces **68** establish line contact with an annular corner of the annular shoulder, thereby developing a force that urges the wiper bar elements **44** radially inwardly, reducing the overall dimension of the spear stop mechanism and allowing it to slide easily through the reduced diameter bore of the high strength tubing. Because of the movable wiper bars **44**, the spear stop mechanism of the present invention is readily adaptable for utilization even where the tubing has variations in dimension.

In view of the foregoing, it is apparent that the present invention is one well adapted to attain all of the objects hereinabove set forth together with other advantages which will become obvious and inherent from a 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 features and subcombina-

tions. As many possible embodiments may be made of this invention without departing from the spirit or scope thereof, it is to be understood that all matters herein set forth as shown in the accompanying drawings are to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A wire line spear mechanism adapted to be lowered into a well for retrieving broken wire line from the production tubing of wells, said mechanism comprising:

a body portion having means for establishing connection of said body portion to a string of manipulating conduit that is extended into the production tubing;

a wire line spear being connected to the lower extremity of said body portion and including means for engaging broken wire line within the production tubing;

a plurality of tubing wiper means being retained in said body portion and being radially movable relative to said body portion and biased outwardly from said body portion to centralize said wire line spear inside said production tubing and to prevent said wire line spear from extending beyond convolutions of broken wire line more than a fixed distance between said wiper means and said wire line spear.

2. A wire line spear mechanism as recited in claim **1**, including:

finger means projecting downwardly from said wiper means, said finger means engaging convolutions of the broken wire line within said tubing and preventing said convolutions from extending beyond said spear mechanism more than the fixed distance between said wiper means and said spear mechanism as said spear is lowered into engagement with said convolutions to cause connection to be established between said spear and the broken wire line, said finger means also being of arcuate configuration and substantially conforming to the curvature of the internal surface of the tubing.

3. A wire line spear mechanism as recited in claim **2**, wherein:

cam means is formed on said finger means and disposed for contact with convolutions of broken wire line as said spear mechanism is lowered into said production tubing, said cam means imparting downward and inward movement to said convolutions away from the internal surface of said production tubing.

4. A wire line spear mechanism as recited in claim **1**, including:

transition means being provided on said tubing wiper means and being responsive to contact with an internal shoulder defined by connection of tubing of smaller internal diameter above tubing of larger internal diameter in said well to cause inward movement of said wiper means to conform to the smaller internal diameter upon upward movement of said spear mechanism within the production tubing.

5. A wire line spear mechanism as recited in claim **4**, wherein:

said transition means comprises cam surfaces formed on the upper portion of said wiper means and reacting against said internal shoulder, causing said wiper means to move inwardly to assume the smaller internal dimension of said upper tubing.

6. A wire line spear mechanism as recited in claim **4**, wherein:

said tubing wiper means have arcuate surfaces formed thereon, said arcuate surfaces substantially conforming to the internal surface of the tubing within which spear mechanism is received; and

said transition means being of arcuate configuration and substantially conforming to the curvature of an internal annular shoulder defined by connection of tubing of smaller internal diameter above tubing of larger internal diameter.

7. A wire line spear mechanism as recited in claim **1**, wherein:

the body portion having a plurality of wiper recesses formed therein;

said wiper means comprising a plurality of wiper bars equally spaced about the periphery of the body portion, movably disposed within said wiper recesses;

a retainer provided on the body portion for retaining the wiper bars in assembly with the body portion; and

spring recesses formed in said wiper bars, and including compression springs being retained at least partially within said wiper recesses.

8. A wire line spear mechanism for retrieving broken wire line from the production tubing of wells, said mechanism comprising:

a cylinderically shaped body portion being externally threaded on both ends and having a plurality of wiper recesses formed about its external periphery;

a plurality of tubing wiper means being carried by said body portion;

a plurality of tubing wiper bars equally spaced about the periphery of the body portion, movably disposed within said wiper recesses, having recesses formed in said wiper bars;

finger means projecting downwardly from said wiper bars having an inwardly and upwardly tapered cam surface, said finger means engaging convolutions of the broken wire line within said tubing and preventing said convolutions from extending beyond said spear mechanism more than a fixed distance between said wiper means and said spear mechanism as said spear mechanism is lowered into engagement with said convolutions to cause connection to be established between said spear and the broken wire line;

a transition means formed on said wiper bars comprising cam surfaces to permit said spear mechanism to be drawn upwardly through succeedingly smaller diameter tubing;

an urging means comprising compression springs partially disposed within said wiper recesses and said wiper bars recesses and bearing upon said wiper bars, urging said wiper bars outwardly from the body portion;

a wire line spear connected to the lower extremity of said body portion and including means for engaging convolutions of broken wire line within the production tubing.

* * * * *