

[54] **METHOD AND APPARATUS FOR REESTABLISHING UNDERWATER GUIDE LINES**

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[58] Field of Search .... **166/5, .6, 54.5; 175/7; 114/221, 221.1**

[56] **References Cited**

**UNITED STATES PATENTS**

|           |        |                   |          |
|-----------|--------|-------------------|----------|
| 3,050,139 | 8/1962 | Hayes.....        | 175/7    |
| 2,249,358 | 7/1941 | Haynes.....       | 166/54.5 |
| 3,236,302 | 2/1966 | Postlewaite ..... | 175/7    |
| 3,452,815 | 7/1969 | Watkins .....     | 166/5    |
| 3,361,199 | 1/1968 | Haeber et al..... | 166/5    |

3,603,386 9/1971 Talley.....175/7

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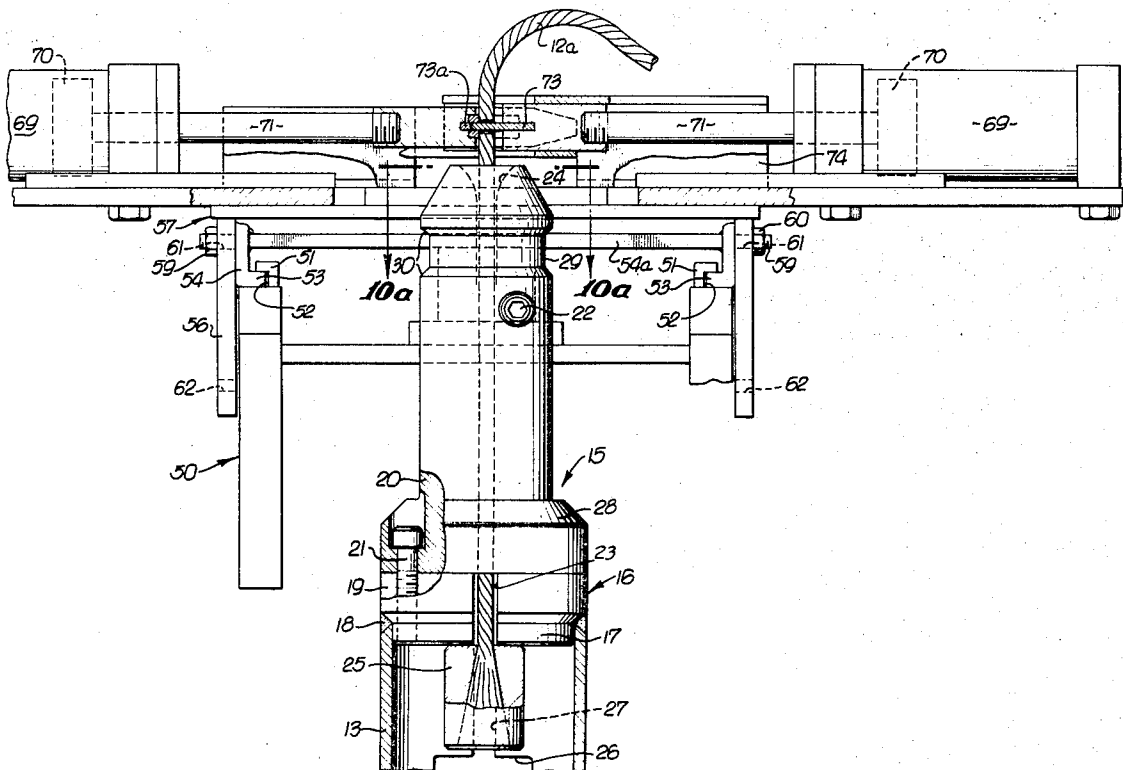
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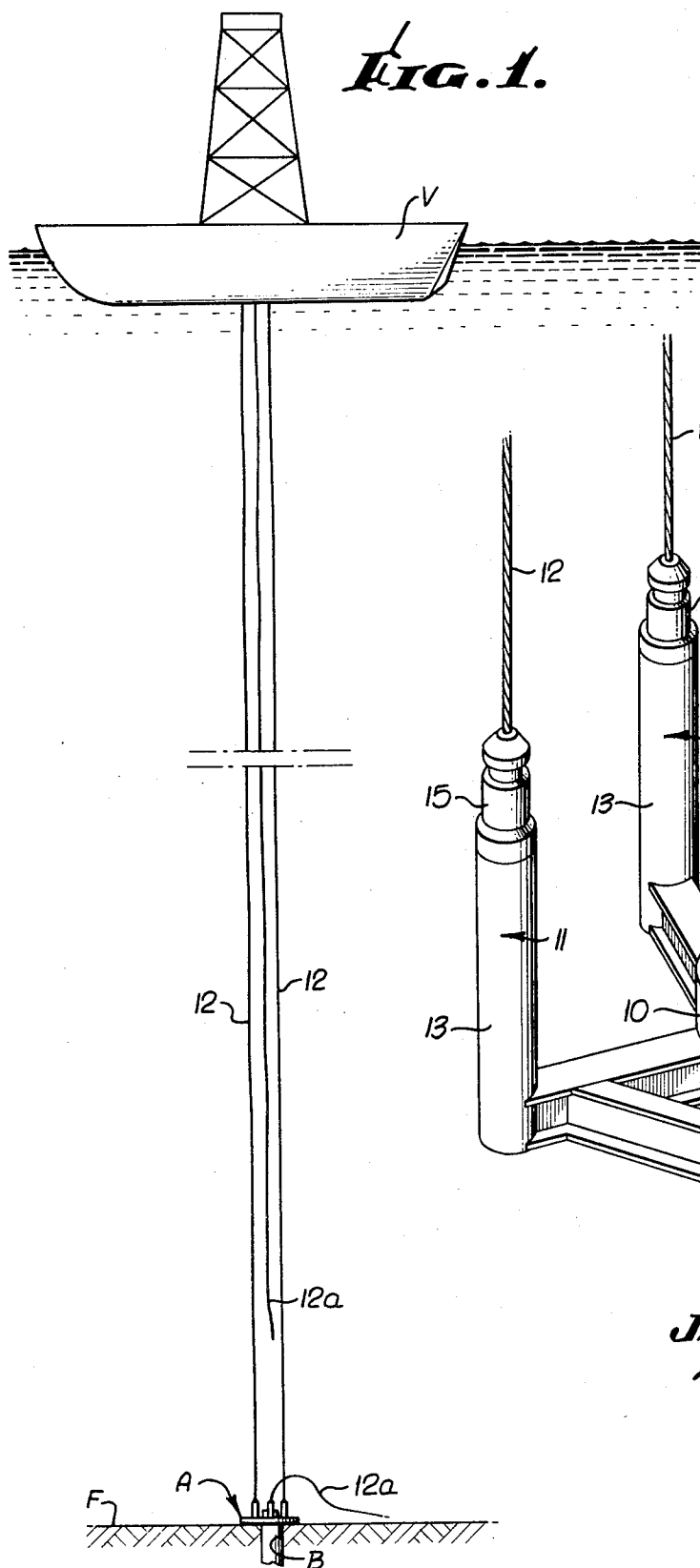
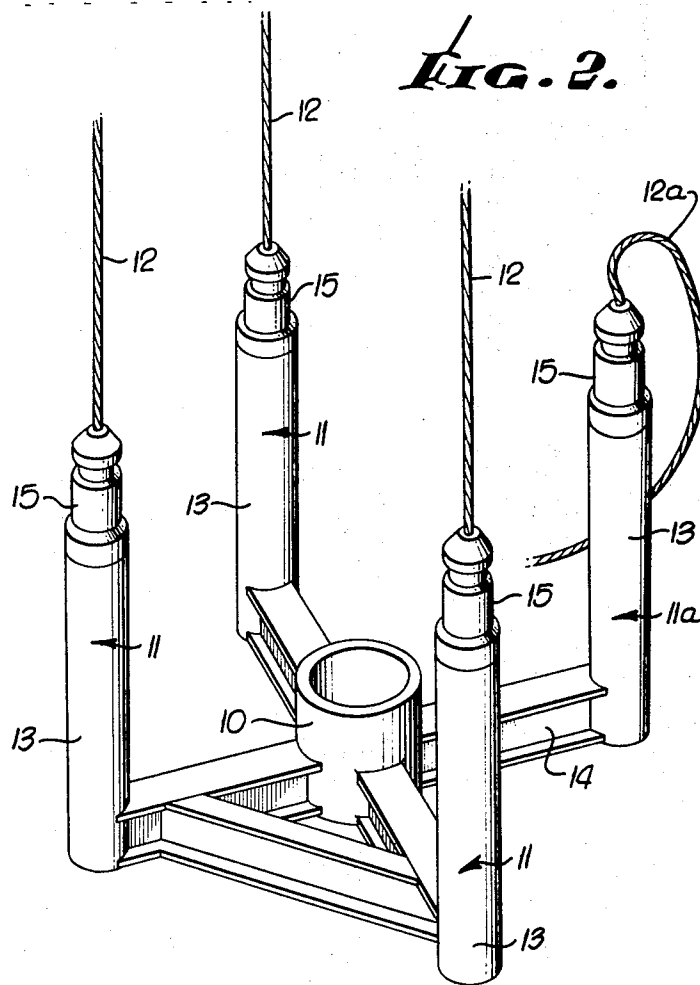
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[57] **ABSTRACT**

To replace a broken underwater guide line or cable extending from a guide post, at a well bore location, to a floating drilling vessel, a remotely operable apparatus is lowered along one or more intact guide lines and accurately positioned to cut off the disrupted line at the top of the guide post, whereupon a replacement intact guide line is attached to a connector carried by a remotely operable apparatus, and lowered through the water to position the connector over the guide post and firmly secure it thereto, the apparatus being released from the underwater connector and withdrawn. If the line secured to the connector breaks, such line can be severed at the top of the connector and the connector withdrawn to the drilling vessel, a replacement intact line being secured to the connector, or a substitute therefor, which are lowered to the guide post and secured thereto. At any time, the connector with an intact line attached thereto can be released from the guide post and withdrawn to the drilling vessel.

**47 Claims, 20 Drawing Figures**

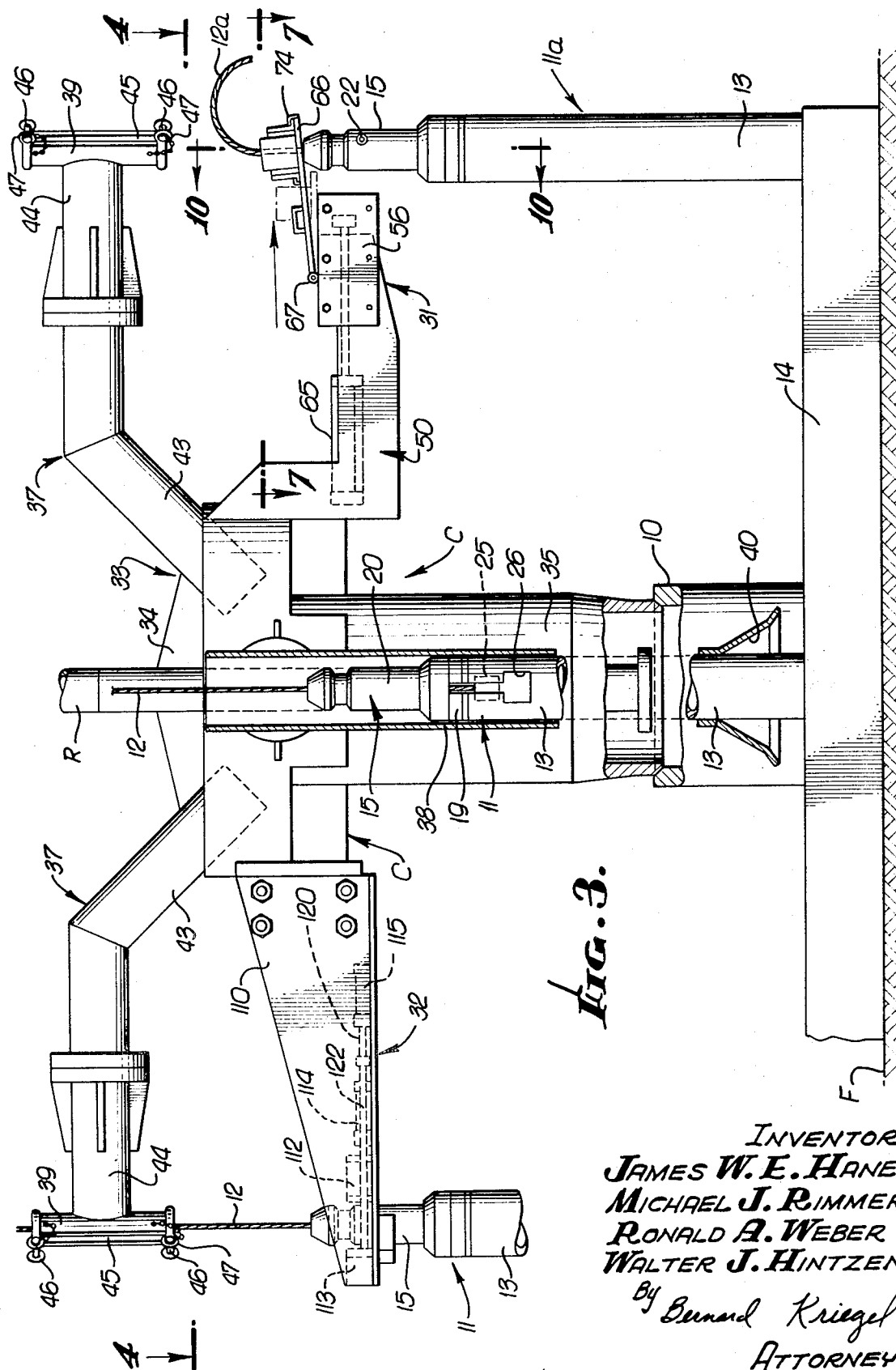


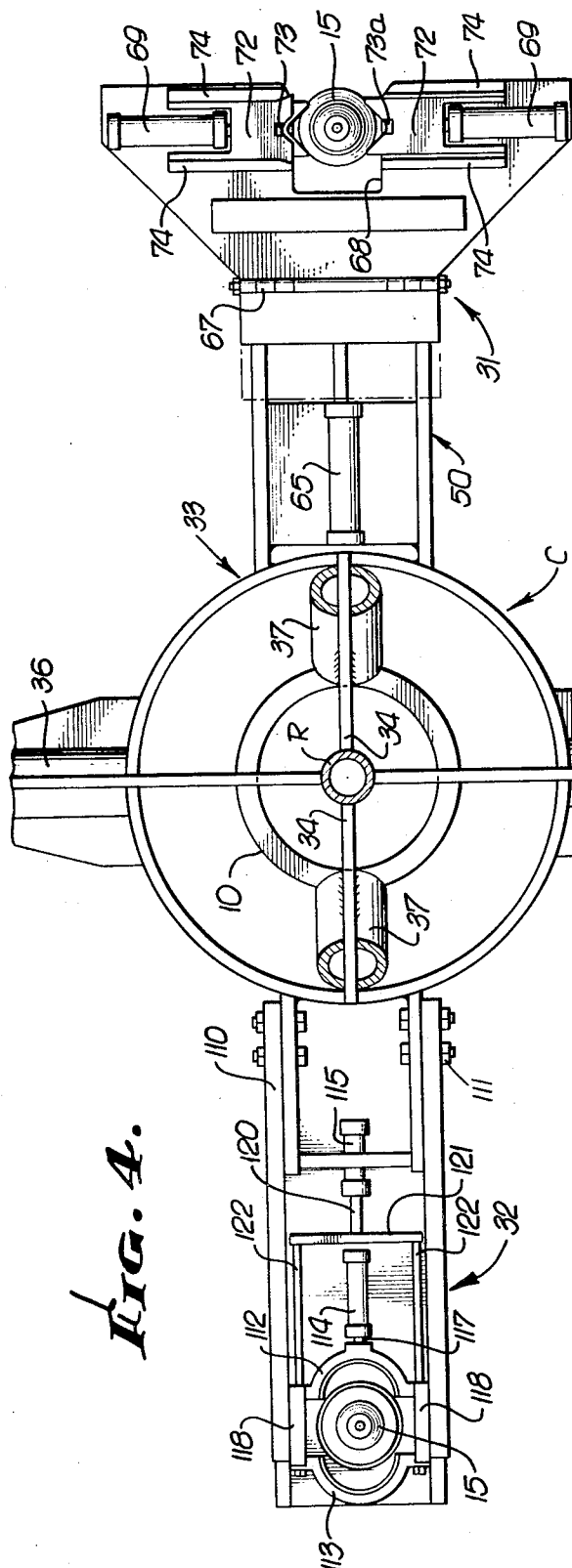
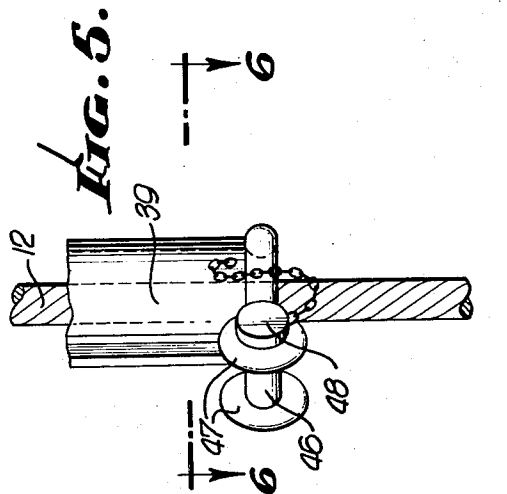
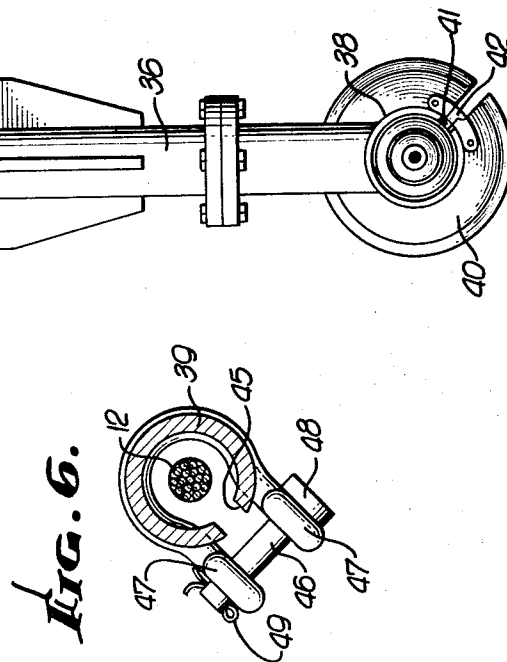


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**FIG. 7.**

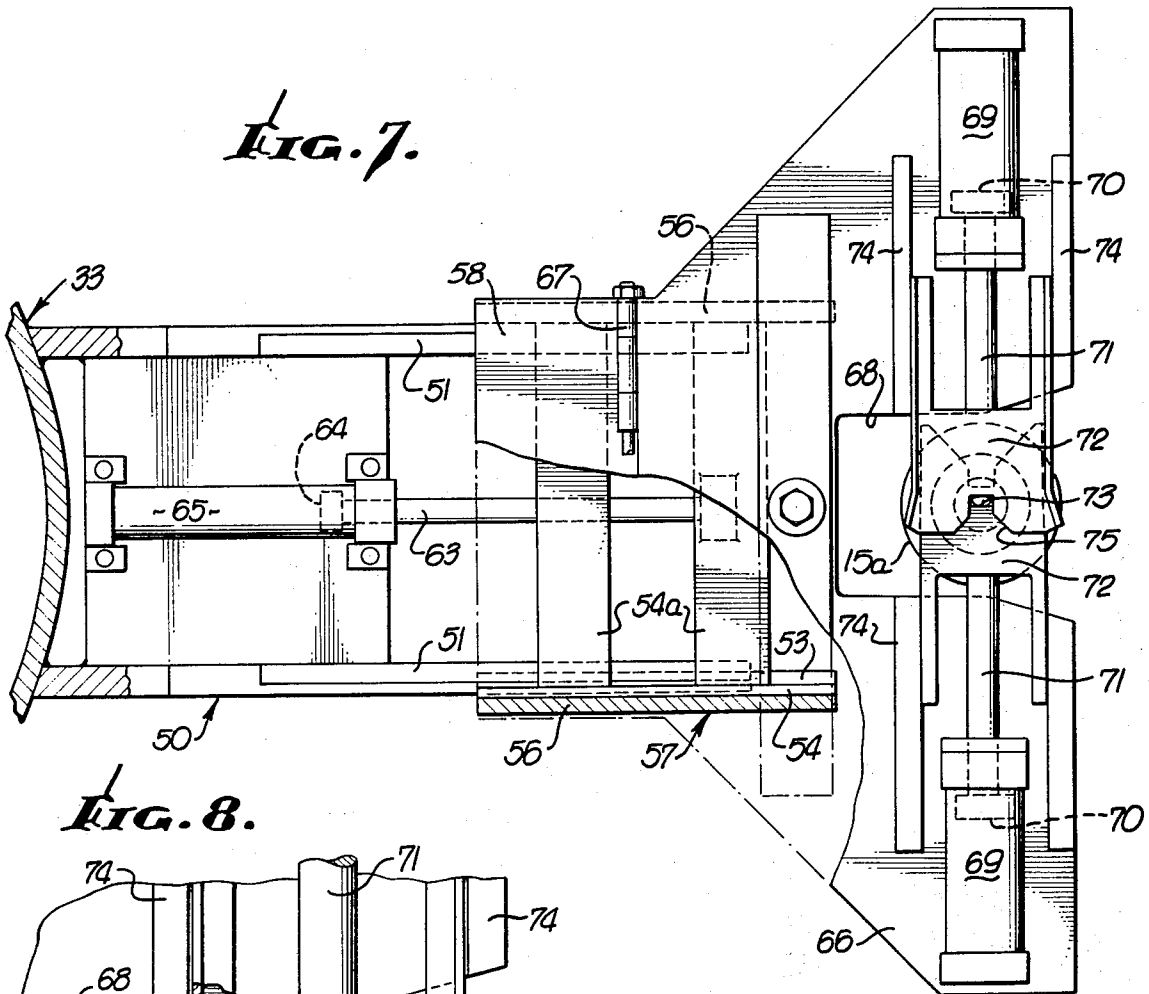


**FIG. 8.**

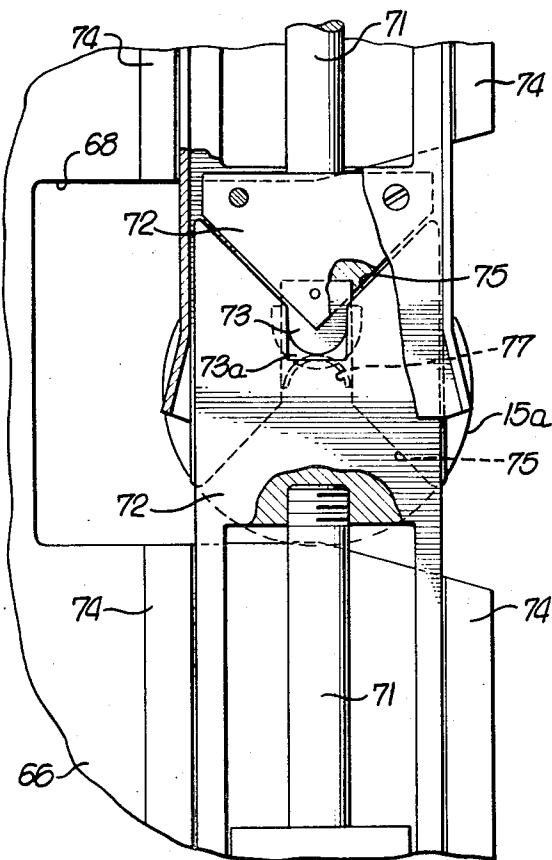
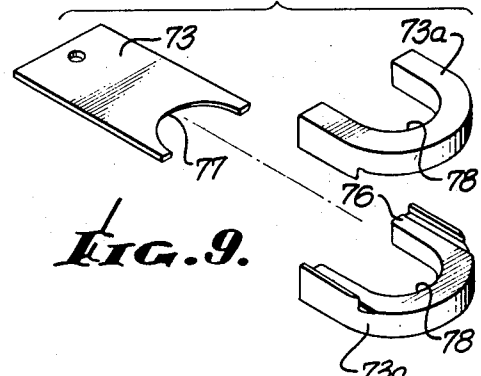
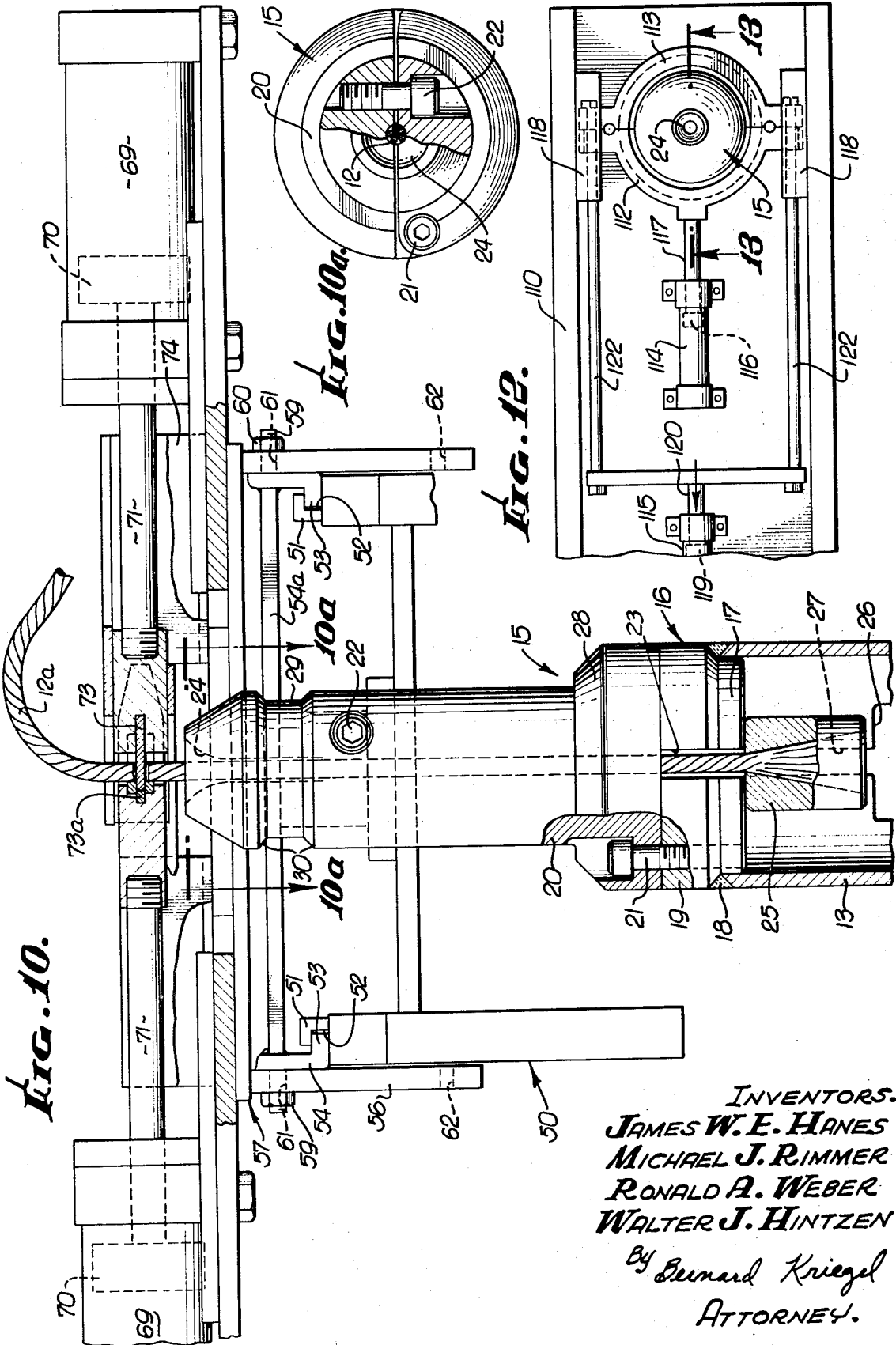


**FIG. 9.**

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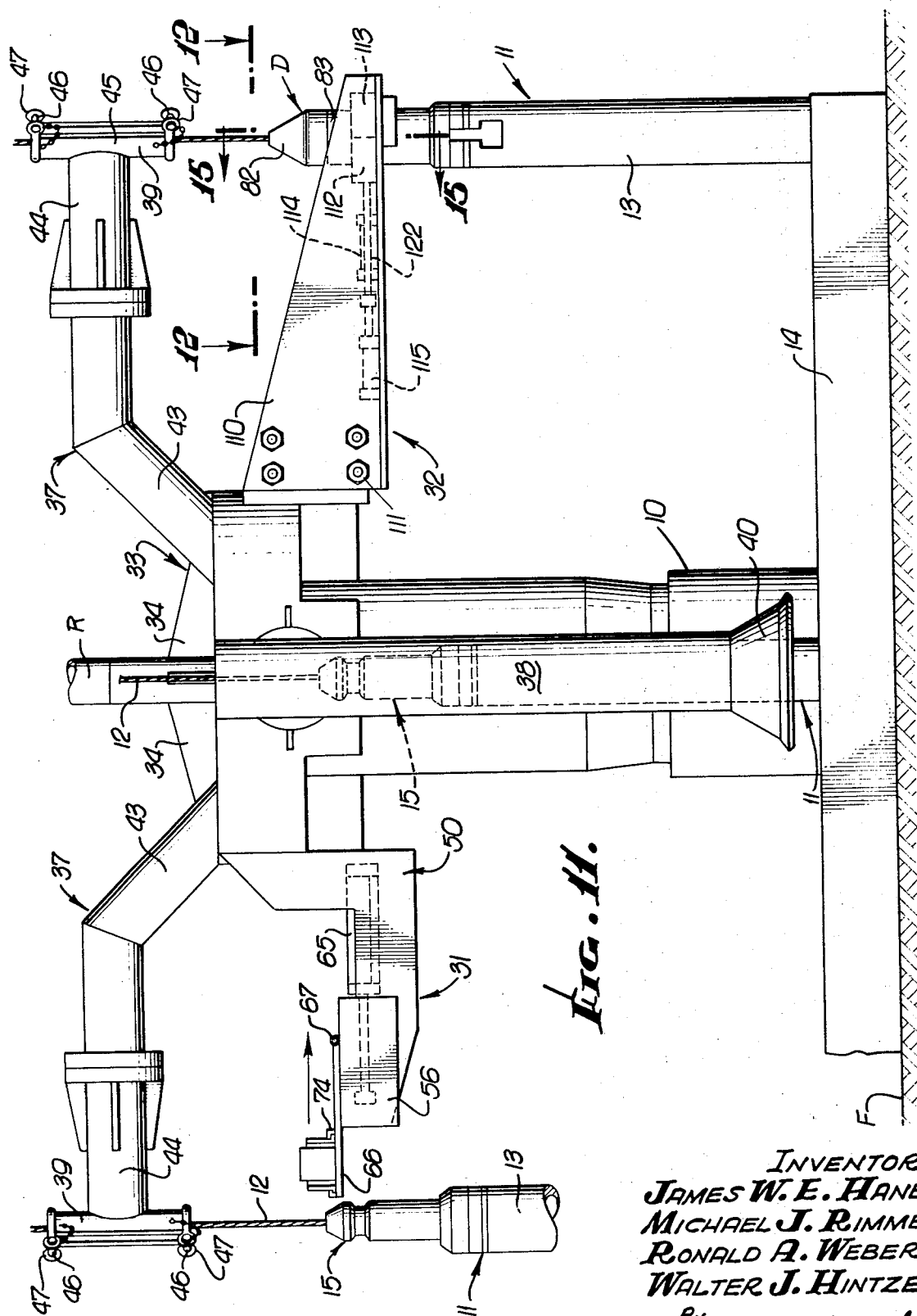
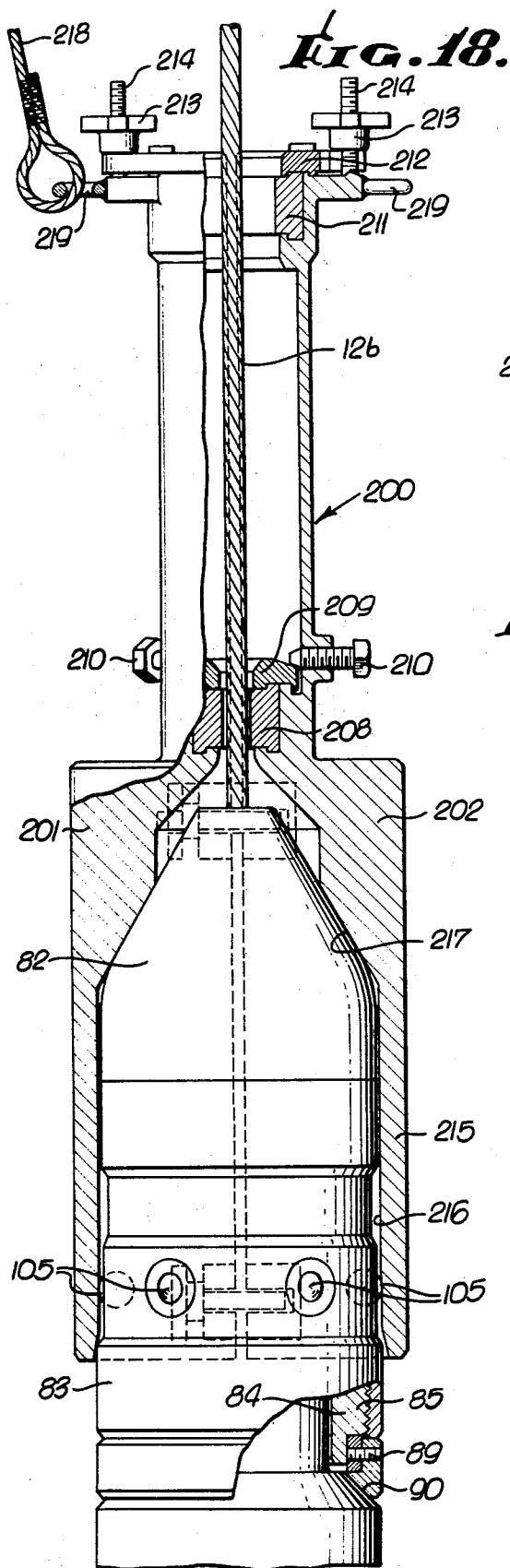
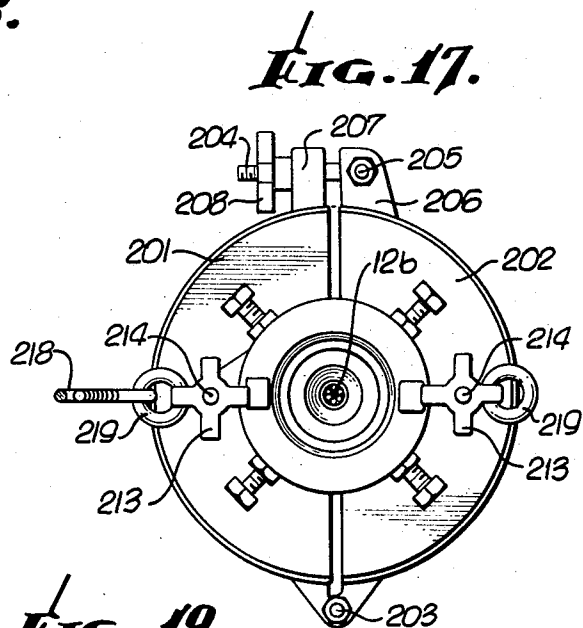
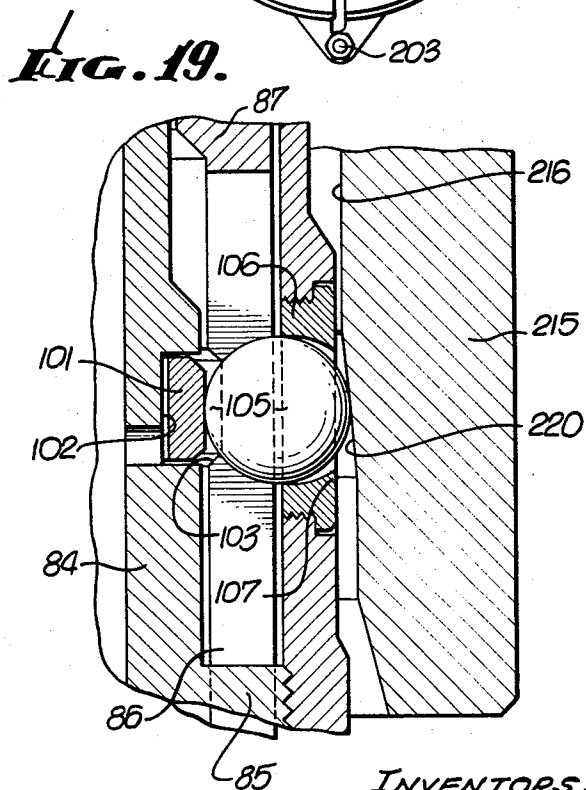


Fig. 11.

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## METHOD AND APPARATUS FOR REESTABLISHING UNDERWATER GUIDE LINES

The present invention relates to well bore apparatus, and more particularly to wireline or cable guidance systems for directing equipment between the region at the top of an underwater well bore and a drilling vessel floating in the water above the well bore.

In the underwater drilling of a well bore from a floating vessel, a guidance system is required for securing reentry of equipment in the well bore, or the placing of equipment in appropriate connection with apparatus disposed at the top of the well bore. It is common practice to use guide lines extending from the ocean floor to the drilling vessel to accomplish the above purposes. However, during the course of drilling the well bore, it is fairly common for one or more of the guide lines to break. Where the water is not too deep, and divers can be sent down to the floor of the body of water, the replacement of the guide line has presented no particular problem. In deep water beyond diver depth, the operation of replacing a broken guide line, or of releasing a guide line when it is no longer required, poses serious problems and difficulties.

As a rule, wellhead structure is disposed at the top of the underwater well bore, that includes a plurality of vertical guide posts or fixtures, to each of which a wireline is secured extending to the drilling vessel. By virtue of the present invention, a method and apparatus is provided for cutting a guide line that has failed in such manner that the remnant piece below the cut will drop into the post or fixture and not interfere with the reconnection of an intact guide line to the post or fixture. The cutting of the guide line is accomplished remotely under the control of an operator on the drilling vessel, since the operation is performed in connection with one or more guide lines that have failed in deep water beyond normal diver operating depth.

The invention further contemplates the provision of a method and apparatus for securing an automatic connector to the lower end of a replacement guide line and lowering the same to the post from which the disrupted guide line has been severed, the connector being appropriately indexed and attached to the post or fixture at the wellhead base, the apparatus being released from the connector, which remains securely locked to the post and with the replacement guide line firmly secured thereto and extending to the drilling vessel floating at the surface of the body of water.

The invention further contemplates a method and apparatus for severing a broken guide line from an automatic connector that has previously been attached to a post or fixture, and then releasing the connector from the post or fixture for securing of a replacement guide line to the connector, its rerunning to the post or fixture, its appropriate indexing with respect to the post or fixture, and its automatic connection thereto, all operations being performed remotely, as from the drilling vessel.

An additional objective of the invention is to provide a method and apparatus for releasing an automatic connector from a post or fixture to which it has been secured, with the guide line attached thereto, and retrieving the same together with the guide line.

This invention possesses many other advantages and has other objects which may be made more clearly ap-

parent from a consideration of several forms and methods embodying the invention. These forms and methods are shown and described in the present specification and in the drawings accompanying and constituting a part thereof. They will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense.

Referring to the drawings:

FIG. 1 is a diagrammatic view disclosing a plurality of guide lines extending between a floating drilling vessel and a wellhead structure at an ocean floor;

FIG. 2 is an isometric view of the wellhead structure, with guide lines secured to its guide posts;

FIG. 3 is a side elevational view, parts being shown in section, of an apparatus embodying the invention in association with the wirelines and guide posts of FIG. 2;

FIG. 4 is a section taken along the line 4—4 on FIG. 3;

FIG. 5 is a side elevational view of the lower portion of one of the guide spools forming part of the apparatus disclosed in FIG. 3;

FIG. 6 is a section taken along the line 6—6 on FIG. 5;

FIG. 7 is an enlarged view taken along the line 7—7 on FIG. 3;

FIG. 8 is an enlarged top plan view of the cutter portion of the apparatus, with the cutters in their final position after having severed a wireline;

FIG. 9 is an exploded isometric projection of the cutter elements;

FIG. 10 is an enlarged vertical view, parts shown in side elevation, taken along the line 10—10 on FIG. 3;

FIG. 10a is a section taken along the line 10a—10a on FIG. 10;

FIG. 11 is a view corresponding to FIG. 3, with the apparatus turned 180° for connecting an auxiliary head to a guide post;

FIG. 12 is an enlarged view taken along the line 12—12 on FIG. 11;

FIG. 13 is an enlarged vertical section, parts being shown in side elevation, taken along the line 13—13 on FIG. 12;

FIG. 14 is an enlarged fragmentary section of a portion of the apparatus disclosed in FIG. 13, disclosing the connector in a released condition with respect to a guide post;

FIG. 15 is a view corresponding to FIG. 13, taken along the line 15—15 on FIG. 11, with the connector secured to the upper head of the guide post;

FIG. 16 is an enlarged fragmentary vertical section of a portion of the apparatus disclosed in FIG. 15;

FIG. 17 is a top plan view of a tool for releasing the connector from a guide post;

FIG. 18 is a vertical section, parts being disclosed in side elevation, of the releasing mechanism disposed over a connector attached to a guide post;

FIG. 19 is an enlarged fragmentary section through a portion of the apparatus disclosed in FIGS. 17 and 18.

As illustrated in the drawings, a wellhead structure or base A is secured in a known manner to the ocean floor F, the well bore B extending downwardly into the formation from the central wellhead 10 of the structure. Such structure includes a plurality, such as four, of ver-

tical guide posts 11, 11a spaced 90° from one another. To each of the guide posts a wire cable or guide line 12, 12a is secured that extends upwardly to a drilling vessel V floating on the body of water, and from which the drilling and other operations are performed. The guide lines 12, 12a are used for lowering equipment from the drilling vessel into the well bore and to the location of the well bore above the ocean floor, to be assured that such equipment will enter the well bore through the wellhead 10, or will otherwise be appropriately related to the wellhead, or other equipment that may have been previously connected or associated with the well-head.

In the event of breaking of one of the guide lines 12a, or, for that matter, of a plurality or all of the guide lines, which for example, may result from excess stress being placed thereon by the heaving of the vessel, such guide line or lines must be replaced to reestablish an appropriate guiding system between the drilling vessel and the wellhead structure. Methods and apparatus for accomplishing such replacement are among the subjects matter of the present invention.

Each guide post 11, 11a (FIGS. 3 and 10) includes an elongate lower post section 13 suitably affixed to and extending upwardly from the base 14 of the well-head structure. A head 15 is secured to the upper end of this lower section. As illustrated most clearly in FIG. 10, the head includes a main body portion 16 having its lower end 17 piloted into the lower section 13 and secured thereto, as by welding material 18. This main body includes an upper semi-cylindrical portion 19 and a companion semi-cylindrical portion 20 pivoted with respect thereto. Thus, a vertical hinge screw 21 attaches the lower portion of the body hinge section 20 to the lower part of the fixed body section 19, allowing the hinge section 20 to swing away from the fixed section 19 and expose the hollow interior of the latter, the hinge section being secured to the fixed section by a locking screw 22 extending into an upper portion of the hinge section and threadedly secured to the fixed section, so as to complete the upper post head portion 15 of the guide post structure. The fixed and hinged body sections 19, 20 have a central passage 23 extending completely therethrough of a diameter greater than the diameter of the wireline 12 or 12a, to be disposed therein, the lower end of such passage opening into the hollow post section 13 below the pilot portion 17, and its upper end being constituted as an upwardly flaring mouth 24.

The lower end of a cable or guide line is disposed within and secured to a spelter socket 25 in a known manner. The locking screw 22 is removed so that the hinge section 20 can be swung to an open position, the spelter socket then being inserted through a window 26 in the lower guide post section 13, with the wireline moving into a slot 27 in the lower guide post section and lower portion of the main body 16, the line then being elevated so that the upper end of the spelter socket bears against the lower end of the pilot portion 17, whereupon the hinge section 20 is swung to a closed position and the locking screw 22 replaced, thereby retaining the lower portion of the wireline in the guide post 11 or 11a, the wireline extending upwardly therefrom. Each guide post head 15 has a lower stop shoulder 28 tapering in an upward direction, and

also an upper groove 29 which may be used subsequently for securing an auxiliary or releasable guide post head thereto, as described hereinbelow, the upper and lower sides 30 of the groove being inclined, diverging in a lateral outward direction away from each other.

With all of the guide lines secured to the guide posts, the wellhead structure A is lowered from the drilling vessel V to its desired location on the ocean floor F and is secured thereto, in a known manner. If one of the guide lines 12a breaks, such as disclosed in FIG. 2, the portion of the broken guide line secured to its post 11a is to be severed at the upper end of the guide post head 15, and a replacement guide line is to be reattached to the guide post, all of the operations being conducted remotely from the floating vessel, in view of the fact that the wellhead structure is disposed in deep water beyond the normal operating depth of a diver.

As disclosed in the drawings, an apparatus C is provided, including a mechanism 31 for severing the broken line 12a closely adjacent to the upper end of the guide post head, so that the lower part of such severed line can drop downwardly into the hollow post 13, leaving the post free for reconnecting a replacement cable or flexible line thereto. The apparatus C also includes a holding mechanism 32 for lowering and resealing the replacement line to the post.

As shown, the apparatus C includes a frame structure 33 having a central body portion 34 adapted to be attached to the lower end of a running string R, which may be a tubular string of drill pipe, or the like, adapted to be lowered downwardly from the drilling vessel. The frame includes a central locator member 35 adapted to engage the wellhead structure 10, and also generally radial arms 36, 37, each of which is secured to a guide device 38 or 39 for guiding the structure along the unbroken guide lines 12 that remain. As disclosed, a pair of diametrically opposite arms 36, 36 are each secured at their outer ends to a guide tube 38 having a lower flaring mouth or guide cone 40, so that the guide tube 38 can slide down along an intact wireline 12 and also slide over and downwardly along a guide post 11 secured to such wireline. Each guide tube has a vertical slot 41 through which a guide line can be inserted into its interior, a suitable gate 42 then being placed across such slot to prevent removal of the guide line from the guide tube 38.

The other pair of arms 37 are diametrically opposite each other and have inner portions 43 secured to the central part 34 of the frame and diverging upwardly and laterally outwardly from such central portion. Each of such arms is suitably connected to an arm extension 44 having a spool 39 at its outer end provided with a slot 45 into which a wireline or cable can be inserted, if intact, the wireline being retained within this spool by a suitable retainer pin 46 (FIGS. 5, 6) projecting through ears 47 extending laterally from the spool on opposite sides of its slot, a head 48 on the pin engaging one of the ears and a cotter pin 49 inserted through the other end of the pin to hold it in place.

As specifically disclosed in the drawings, three of the four guide lines are intact, and one of them 12a is broken. Thus, the three intact guide lines serve to guide the apparatus C downwardly through the water to the operating location of the apparatus. If any two of the guide lines are intact, the apparatus can be ap-

appropriately related to the broken line 12a and the guide post 11a attached thereto for the performance of the severing and guide line replacement operation, as described hereinbelow. In fact, through use of a single intact guide line, aided by a television camera, the apparatus to be described can be placed in appropriate relation to the guide post 11a, from which the broken line 12a is to be severed, and to which a replacement line is to be connected. In fact, it is possible to sever and replace a guide line with no intact guide lines existing, with the aid of a television camera.

The mechanism 31 for cutting the wireline 12a is carried on a cutter supporting frame portion 50 that underlies and is located vertically centrally of one of the arms 37 and its extension 44. Such apparatus (FIGS. 3 to 10, inclusive) includes the above-noted supporting frame portion which carries a pair of spaced generally horizontal tracks 51 having outwardly facing grooves 52 therein and affixed to vertical side members 55. Within the grooves are slidably located inwardly extending flanges 53 of slides 54 held in spaced relation by cross members 54a secured thereto. The sides 56 of an adjustable frame 57 are adjacent to and outwardly of the side members 55, the adjustable frame including a horizontal platform 58 extending across the upper ends of the side members 56 and which is suitably secured thereto. The vertical side members 56 are attached to the slides 54 by cross bolts 59 extending therethrough and through the side members, suitable nuts 60 being threaded on the outer end portions of said bolts to secure the adjustable frame in a desired vertical position relative to the cutter supporting frame portion. As disclosed, an upper row of holes 61 is provided in the vertical side members, and also a lower row of holes 62, which allows the adjustable frame 57 to be secured to the slide portions 54 in two vertical positions, as described hereinbelow. The cross members 54a are attached to the slides 54, a piston rod 63 being secured to one of such cross members 54a, which is connected to a piston 64 slidable within a horizontal cylinder 65 suitably affixed to the cutter supporting frame portion 50. By introducing fluid under pressure into the head end or rod end of the cylinder, the slides 54 and adjustable frame 57 can be moved radially of the cutter supporting frame portion 50.

A tiltable base plate 66 is secured to the horizontal platform 58 by a hinge 67, this base plate extending radially outwardly beyond the horizontal platform and carrying the cutter mechanism itself. The plate has a central opening 68, and on each side of such opening is mounted a cutter cylinder 69 affixed to the base plate 66, the axis of the cylinder being normal to the axis of the adjustable frame shifting cylinder 65 and its piston 64. Each cutter cylinder has a piston 70 therein connected to a piston rod 71, which is attached to a head 72 carrying a cutter blade 73 or 73a, each head being slidably supported in a guideway 74 secured to the base plate 66. Each head or slide has a generally V-shaped recess 75 in its inner end, the sides of which converge toward a cutter blade 73 or 73a affixed to the head or slide in any suitable manner. Thus, the tapered sides 75 of the recess will engage a wireline 12a projecting upwardly from a post head 15 and center the wireline as the heads 72 move inwardly toward each other, such that the blades 73, 73a mounted in the inner portion of

each recess can engage and sever the wireline. As disclosed (FIG. 9), one of the heads carries a single blade 73 and the other head carries a pair of opposed blades 73a secured to each other to define an opening 76, into which the single blade 73 can slide, this single blade having a cutting edge 77 to engage the wireline and force it against the inner throat 78 of the double blade 73a, and then cutting the wireline in double shear, the cutting edge 77 of the single blade moving completely through the wireline 12a in effecting the cutting action.

The various hydraulic lines to the head ends and rod ends of the adjustable frame shifting cylinder 65 and the cutter cylinders 69 are not disclosed in the interest of avoiding complexity in the drawings. Such lines are connected to the cylinders and extend to the drilling vessel V for the introduction of hydraulic fluid under pressure into the appropriate lines, depending on the direction in which the adjustable frame 57 is to be shifted and the cutters are to be actuated.

The cutter mechanism is located on the frame in such position that when the central locator member 35 engages the wellhead structure 10, the cutters 73, 73a will be located in a plane slightly above the upper end of the guide post head 15 from which the broken wireline 12a is extending. One of the V-shaped centering heads 72 will be located in alignment with the tapered upper end 15a of the guide post, the opening 68 of the base plate 66 being aligned with the post head to permit the base plate portions on opposite sides of the opening to be disposed on opposite sides of the post head 15, so that the cutters can be shifted inwardly toward one another to sever the line. During such inward shifting of the cutters, one of the heads 72 will engage the tapered upper end 15a of the guide post and tilt the base plate 66 upwardly about its hinge 67 to the extent at which it is slightly inclined and the cutters 73, 73a are located above, but closely adjacent, the upper terminus of the guide post head 15, so that the severing of the cable 12a occurs a very short distance above such terminus. Upon severing of the cable or wireline 12a, its lower portion drops downwardly by gravity into the hollow guide post portion 13.

After the severing action has been completed, the apparatus C is elevated on the running string R to the drilling vessel V, and a connector D with a replacement guide line 12b secured thereto mounted in the connector supporting portion 32 of the apparatus (described hereinbelow) and lowered along the intact guide lines 12 into appropriate position for coupling to the guide post 11a, which is now clear of the broken or disrupted guide line 12a.

The connector is illustrated in FIGS. 11 to 16, inclusive, and more particularly in FIGS. 13 to 15. It includes a releasable guide post auxiliary head 80, including a post top 81, the upper portion 82 of which is frusto-conical, tapering in an upward direction. The lower portion of this top is threadedly secured to an outer sleeve 83 depending therefrom, the lower end of which is threadedly attached to an inner sleeve 84, the threads on the latter being provided on circumferentially spaced, longitudinally extending key portions 85 that extend through circumferentially spaced, elongate slots 86 in a retainer sleeve 87 disposed in an annular space 88 between the two sleeve members 83, 84. The lower end of the retainer sleeve 87 is attached

by screws 89 to a stop ring portion having a lower tapered surface 90 conforming to and engageable with the tapered portion 28 on the post head 15. The inner sleeve 84 has an internal diameter slightly greater than the external diameter of the upper portion of the guide post head 15 above its tapered stop surface 28, the body portion 81 being hollow with an inner wall 91 conforming to and slightly greater than the outside diameter of the upper portion of the guide head 15, a tapered wall 92 conforming to the tapered end 15a of the initial guide post head 15, and a cavity 93 thereabove adapted to receive a splter socket 94 to which the lower end of the wireline 12b is secured, which extends through a central opening in the upper body portion, this splter socket being adapted to engage a downwardly facing shoulder 95 surrounding the upper opening or wireline passage 96, and being prevented from dropping downwardly of the upper body portion by one or a plurality of screws 97.

The body structure, which includes the upper body portion 81, outer sleeve 83 and innersleeve 84, can be disposed over the upper head portion 15 of the initial guide post 11a, the structure carrying a split lock ring 98 disposed in a longitudinal circumferential space 99 between the upper end of the inner sleeve 84 and a downwardly facing shoulder 100 of the upper body portion, the ring 98 being adapted to contract inherently into the guide post groove 29. The retainer sleeve 87 is slidable into the circumferential space behind this lock ring 98, when the latter is disposed within the post groove 29, to retain the lock ring in such groove and thereby secure the auxiliary guide post head D to the initial guide post head 15.

The retainer sleeve 87 is secured in its relative upward position, as disclosed in FIG. 15, by a split inherently expansible lock ring 101 mounted in a circumferential groove 102 in the inner sleeve, which is expandable outwardly into a companion internal circumferential groove 103 in the retainer sleeve. When the lock ring 101 is disposed in such groove 103, the upper portion 87a of the retainer sleeve is disposed behind the lock ring 98 to prevent it from being removed from the head groove 29. When the retainer sleeve 87 is located in a relative lower position within the auxiliary post head 80, or below the lock ring 98 (FIG. 13), the latter can expand outwardly from the groove 29, being assisted in such expansion by its engagement with the upper tapered side 30 of the groove. Moreover, during the telescoping of the auxiliary head 80 over the normal guide post head 15, the retainer sleeve 87 is disposed in a lower position, allowing the lock ring 98 to engage the tapered end 15a of the guide post and expand outwardly until it is disposed opposite the guide post groove 29, whereupon it can snap inherently partially thereinto. The extent of inward contraction of the lock ring 98 is limited by an upwardly extending circumferential rim portion 104 thereon engageable with a companion rim portion 105 on the upper body 81 of the auxiliary post. Accordingly, loss of the lock ring 98 from its assembled position in the auxiliary post 80 during its vertical movement through the water is prevented.

The lock ring 101 for securing the retainer sleeve 87 behind the post lock ring 98 can be removed from and prevented from entering the retainer sleeve groove 103

by a release mechanism. Such mechanism includes circumferentially spaced balls 105 mounted in radially located retainers 106 threadedly secured to the outer sleeve 83, the outer portion 107 of each retainer extending inwardly beyond the major diameter of each ball, with the balls projecting laterally outwardly beyond the ball retainers 106 and the outer sleeve 87. Such balls are also received within the elongate retainer sleeve slots 86 and are adapted to engage the lock ring 101. When the balls are pressed radially inwardly, they will shift the lock ring 101 inwardly completely into the external groove 102, allowing the retainer sleeve 87 to shift longitudinally along the body members 81, 83, 84 of the auxiliary post head 80. Upward movement of the retainer sleeve 87 is limited by engagement of its portion defining the lower end of its slots 86 with the keys 85; whereas, its downward movement to a lock ring releasing position is limited by engagement of a downwardly facing retaining sleeve shoulder 108 with a companion upwardly facing shoulder 109 on the inner sleeve 84.

As described hereinbelow, the balls 105 are held inwardly by a suitable device which retains the lock ring 101 inwardly and allows the retainer sleeve 87 to drop downwardly with respect to the body, with its upper end below the upper lock ring 98 (FIG. 13). The auxiliary post 80, with the lower end of the wireline 12b secured thereto, is then lowered and placed over the post head 15 to which the wireline is to be secured, the tapered upper end 15a of the post head expanding the lock ring 98 outwardly and the stop ring 90 on the retainer sleeve engaging the tapered stop surface 28 on the post head. The body 81, 83, 84 then moves downwardly with respect to the sleeve 87, the upper lock ring 98 snapping into the groove 29 of the post head 15, and the upper end 87a of the retainer sleeve moving behind this lock ring 98 to retain it in the groove 29, the parts then being in the position illustrated in FIG. 15. The balls 105 are then released, and the outer portion of the lock ring 101 will expand into the internal groove 103 of the retainer sleeve 87, to hold such retainer sleeve in its relative upward position behind the lock ring. An upward pull now taken on the wireline 12b will cause the lock ring 98 to engage the upper side 30 of the post head groove. However, the lock ring 98 cannot shift outwardly out of such groove because of the holding action of the retainer sleeve 87. The retainer sleeve 87 cannot drop downwardly despite the fact that its stop ring 90 has been elevated a short distance above its companion shoulder 28, because of the locking action of the inherently expansible split retainer ring 101.

In the event the auxiliary guide post head 80 is to be removed, the balls 105 are pressed inwardly to remove the lock ring 101 from the internal retainer sleeve groove 103 and the body portion 81, 83, 84 elevated to elevate the lock ring 98 above the upper end of the retainer sleeve 87, which will remain in its lower position by gravity. Continuation of the upward pull will cause the lock ring 98 to engage the tapered upper surface 30 of the guide groove 29 and expand outwardly thereof, thereby releasing the auxiliary post head 80 from the original post head 15.

The mechanism 32 for lowering the auxiliary guide post head 80 and the replacement wireline 12b toward

the guide post 11a, from which the wireline 12a has been severed, or for releasing an auxiliary connector or post head 80 therefrom, is mounted within the guide frame 33 that carries the wireline cutter portion 31 of the apparatus. Such mechanism underlies one of the arms 37. It includes a connector supporting frame portion 110 suitably secured to the central portion of the frame by bolts 111, or the like. A pair of opposed clamp halves 112, 113 of semi-circular shape are shiftable radially of the frame portion 110, and are mounted on such frame portion an appropriate distance with respect to the other guide members 38, 39, such that the lowering of the apparatus on the running string R will bring the central locator member 35 in contact with the wellhead structure 10, with the auxiliary guide post head 80 clamped between the halves 112, 113 and in alignment with and over the post head 15. As disclosed more particularly in FIGS. 3, 4, 11 and 12, a pair of horizontally mounted cylinders 114, 115 are suitably secured to the connector frame portion 110, one of the cylinders 114 containing a piston 116 and piston rod 117, the piston rod being secured to an inner clamp half 112 slidable along suitable opposed guides 118 on the frame, and the other of the cylinders 115 containing a piston 119 attached to a piston rod 120 secured to a cross member 121 forming part of a shiftable frame 122 disposed on opposite sides of the clamp cylinder 114 and inner clamp half 112 and secured to an outer clamp half 113. The introduction of pressure to the head end of cylinder 114 and to the rod end of cylinder 115 will move the clamp halves toward each other, and to the position disclosed in FIGS. 11, 12 and 13, in which inwardly directed flanges 125 on the clamp halves 112, 113 are disposed within an external groove 126 on the outer sleeve 83 and with the cylindrical surface 127 of the clamp halves below such flange engaging the release balls 105, so that they retain the split lock ring 101 in contracted position, and allow the retainer sleeve 87 to drop downwardly to its lowermost position below the upper lock ring 98.

In effecting a connection between the auxiliary guide post head 80 and the guide post head 15 from which the wireline 12a has been severed, the wireline 12b is secured to the upper body portion of the auxiliary head 80, which is then placed within the connector supporting and running portion 32 of the apparatus, fluid under pressure being directed through suitable hydraulic lines (not shown) into the cylinders 114, 115 to shift the clamp holding members 112, 113 toward each other, in which they embrace the outer sleeve 83 and shift the release balls 105 inwardly to allow the retainer sleeve 87 to drop downwardly. Prior to the time that this step is taken, the frame of the apparatus will have been positioned 180° from the position used for cutting the broken wireline 12a, or to the position illustrated in FIG. 11, the apparatus then being lowered by the running string R and guided by the intact wirelines 12, the auxiliary head 80 being in appropriate alignment with the post head 11a so that it can more thereover, to the extent limited by engagement of the central locator member 35 with the wellhead 10. Prior to such engagement, the lock ring 98 will have engaged the tapered portion 15a of the post head 15 to expand the ring 98 outwardly and allow it to ride past the tapered portion and into alignment with the post head groove 29, the

lock ring snapping thereinto. The stop ring 90 engages the tapered stop shoulder 28 on the post head 15, which will prevent further downward movement of the retainer sleeve 87, the body portion 81, 83, 84 of the auxiliary post head and the upper lock ring 98 moving downwardly of the retainer sleeve to the extent at which the retainer sleeve 87 is located behind the lock ring 98, with the lock ring 98 in the lower portion of the elongate post head groove 29, which is greater in longitudinal extent than the lock ring itself. Fluid under pressure is then directed into the opposite ends of the cylinders 114, 115 to shift the clamp halves 112, 113 away from each other, releasing them from the actuating balls 105 and from the auxiliary post head 80 itself, allowing the lower lock ring 101 to expand inherently into the retainer sleeve groove 103, with which it is now aligned, thereby retaining the retainer sleeve 87 behind the upper lock ring 98. As assurance that the auxiliary head 80 is securely connected to the inner post head 15, a pull can be taken on the wireline 12b, the lock ring 98 engaging the upper side 30 of its groove 29, thereby advising the operator at the drilling vessel that the connection has been appropriately made. The apparatus C can now be elevated on the running string R to the drilling vessel V, the broken wireline 12a having been replaced by an intact wireline 12b firmly secured to the post 11a.

In the event a wireline 12b secured to an auxiliary guide post head 80 breaks, the same cutter apparatus 31 is used as before, except that the adjustable frame 57 is secured to the slide frame 54, 54a in a higher position, so that the cutters 73, 73a will be appropriately disposed with respect to the auxiliary guide post head 80, the upper terminus of which is located above the upper end of the original guide post head 15. Thus, the vertical side members 56 of the adjustable frame will be secured to the slide frame by bolts 59 passing through the lower holes 62 of the vertical side members, which will position the cutters at the desired higher location.

The apparatus is then lowered along the guide lines 12 with the cutter apparatus 32 retracted radially and with the cutters in an outer or open position for performing a cutting action on the broken wireline 12b. The lowering action occurs until the central locator member 35 engages the wellhead 10, at which time fluid under pressure is directed to the head end of the frame shifting cylinder 65 to shift the frame 57 radially outwardly to a position in which its base plate 66 straddles the auxiliary guide post 80, with its cutters 73, 73a disposed on opposite sides of the guide post 11a and the wireline 12b. The direction of fluid into the head ends of the cutter cylinders 69 will then shift the cutter heads 72 and the cutters 73, 73a inwardly, one of the cutter heads engaging the tapered upper end 82 of the auxiliary guide post head 80 and tilting the base plate 66 and the cutter apparatus connected thereto upwardly, so that the cutter blades are in appropriate position for severing the broken wireline 12b immediately above the upper end of the auxiliary guide post head 80. The cutters move inwardly toward each other to sever the guide line 12b, the severed end projecting only a very short distance above the upper end of the auxiliary head and being unable to interfere with subsequent release of the connector D from the inner guide post head 15. Fluid pressure is then directed into

the rod ends of the cutter cylinders 69 to retract the cutters, whereupon the running string R can be elevated to remove the apparatus to the drilling vessel V.

The apparatus is then shifted 180° so that the spool 39 above the cutter heads and the guide tubes 38 ride along the intact guide lines 12, the clamp halves 112, 113 being disposed in their separated condition. The apparatus is lowered until the locator member 35 engages the wellhead 10, at which time the clamp halves 112, 113 will be disposed on opposite sides of the connector D. Fluid under pressure is then directed into the clamp cylinders 114, 115 to move the clamp halves 112, 113 toward each other, the clamp halves engaging the release balls 105 to project them inwardly and release the lock ring 101 from the retainer sleeve 87, the clamp flanges 125 being disposed in the shallow external groove 126 in the outer body sleeve 83. The apparatus can now be elevated, the body 81, 83, 84 first moving upwardly a short distance with respect to the retainer sleeve 87, to raise the lock ring 98 above the sleeve, whereupon the elevation can continue with the lock ring 98 camming out of the post groove 29 by engaging the upper side 30 of the latter, allowing the connector D to be elevated with the apparatus C to the drilling vessel V.

An intact wireline can then be secured to the connector D, or one secured to another connector can then be clamped between the clamp halves 112, 113 and the apparatus rerun, for the purpose of attaching the connector D to the guide post 11a, in the manner described above, whereupon the clamps are released from the connector and the apparatus C elevated by the running string to the drilling vessel.

In the event a connector D is to be released from a guide post 11a with its associated wireline 120 intact, the tool illustrated in FIGS. 17 to 19 can be used. This tool includes a housing 200 made in two parts 201, 202 pivotally connected to each other by a hinge 203, so that the housing can be opened and placed over the intact wireline 12b at the drilling vessel, whereupon its halves are swung to a closed position and clamped in such position in any suitable manner, as through use of the longitudinally spaced clamp bolts 204, each of which is secured by a pivot bolt or pin 205, to an ear 206 attached to one of the housing sections 202, the bolt being shifted into bifurcated ears or bosses 207 on the opposite housing section 201, and a nut 208 threaded on the bolt to clamp the housing sections together.

The housing sections contain a lower guide bushing 208 loosely straddling the wireline 12b, this guide bushing being held in position by clamp halves 209 overlying and engaging its upper end and forcing its lower end against the housing, the clamps being retained in clamped relation by radial clamp screws 210 threaded in the housing sections and bearing against the upper end of the clamp members 209. An upper guide bushing 211 is held against the housing by clamp members 212 secured to the housing by nuts 213, threaded on bolts 214 secured to and projecting upwardly from the upper end of the housing, bearing against the clamp members 212 themselves.

The lower portion 215 of the housing is enlarged in diameter with respect to its upper portion and has an

inner cylindrical wall 216 of a diameter slightly greater than the external diameter of the connector body 81, 83, the housing having an upwardly tapering frusto-conical inner wall 217 extending upwardly from the upper end of the cylindrical wall and conforming to the upper tapered surface 82 of the auxiliary connector D.

The housing 200 is placed around the wireline and is lowered downwardly therealong by a suitable sand line 218 attached to a loop 219 secured to the upper end of the housing 200. When the location of the connector D is reached, the lower portion 215 of the housing will slide over the connector, the inner wall 216 sliding along the other sleeve 83 and its tapered surface 220 engaging the balls 105 to force them inwardly and release the lower lock ring 101 from the retainer sleeve groove 103. The extent of downward movement of the housing and release of the lower lock ring 101 from the retainer sleeve 83 is indicated to the operator on the drilling vessel by the engagement of the tapered surfaces 217, 82 with one another and the slack which will appear in the flexible line 218. A pull is then taken on the intact wireline 12b, which will elevate the body 81, 83, 84 with respect to the retainer sleeve 87 and allow the body to shift the lock ring 98 upwardly of its companion groove 29 and against the upper tapered wall 30 of the groove, the lock ring 98 expanding outwardly and permitting the withdrawal of the connector D from the inner post head 15, the connector being removed to the drilling vessel V by elevating the intact wireline 12b.

In the use of the apparatus described above, the cutter mechanism 31 and the connector running and retrieving mechanism 32 can be appropriately positioned with respect to the guide post 11a at which the wireline is to be severed and a replacement wireline attached with any two guide lines 12 remaining intact, such two guide lines being 90° apart or 180° apart. In fact, the apparatus can be used with only a single guide line intact, and with the aid of a television camera. As an example, one of the guide tubes 38 can be lowered down the single intact wireline with the frame 57 of the cutter mechanism initially in retracted position, until the location of the guide post 11a, to which the disrupted line 12a is secured is reached, whereupon the mechanism is actuated while the operator is viewing the location of the cutter mechanism through the aid of a television camera, the apparatus being manipulated by the tubular running string R, which will permit the swinging of the apparatus around the post 11 to which the intact guide line 12 is secured. When the cutter mechanism is appropriately positioned with respect to the guide post 11a from which the broken line 12a is to be severed, the cylinder 65 is actuated to shift the cutter apparatus outwardly until the cutters 73, 73a straddle the guide line 12a, at which time the piston in the cutter cylinders 69 is actuated to effect the cutting action. The apparatus can be elevated and withdrawn to the drilling vessel.

The connector D, with an intact wireline 12b secured thereto, is then secured between the clamp halves 112, 113 and the apparatus relowered with the connector positioned outwardly relative to the intact wireline 12, until the location of the guide post 11a is reached, whereupon the apparatus is swung inwardly about the axis of the guide post 11 over which the guide tube 38

has telescoped to a position above and in alignment with the guide post 11a at which the cable 12a had been severed, this position being noted by viewing the picture at the drilling vessel taken by the television camera. Lowering then continues to telescope the auxiliary connector D over the guide post head 15, whereupon the clamps 112, 113 are released and the apparatus elevated to the drilling vessel.

Since two guide lines are now intact, it is a relatively simple matter to reestablish the other two guide lines by cutting the broken lines from each of their guide posts, and then securing auxiliary connectors D thereto, to which intact wireline guides 12b have been secured.

If desired, a broken wireline can be severed at the upper end of a post head 15 and a replacement guide line secured thereto in the absence of any guidance equipment, but through the aid of a television camera. Such action would be more difficult than with the existence of at least a single guide line, but is still possible of performance by appropriately locating the drilling vessel V over the well B, and then shifting the cutter apparatus 31 through manipulation of the tubular running string R, until the operator can see, through aid of a television camera, that the cutter apparatus is appropriately positioned for severing the cable. The apparatus can then be elevated to the drilling vessel and an intact line secured to the connector apparatus 32 and lowered on the connector portion of the apparatus into appropriate position and stabbed over and connected to a post head 15. The clamps 112, 113 are then released and the apparatus C elevated to the drilling vessel.

We claim:

1. The method of reestablishing a disrupted guide line secured to and projecting from an underwater guide post, comprising lowering cutting apparatus on a running string from an above water location through the water to the guide post from which the disrupted guide line projects, said cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the point of exit of said disrupted guide line from the guide post, and effecting actuation of said cutting apparatus from the above water location to cause said cutter means to sever the disrupted guide line closely adjacent to the point of exit of said disrupted guide line from the guide post.

2. In a method as defined in claim 1; said cutting apparatus being oriented to place said cutter means on opposite sides of the guide line, actuation of said cutting apparatus moving cutter elements of said cutter means toward each other to sever the guide line.

3. The method of severing a disrupted guide line secured to and projecting from the upper end of an underwater guide post, comprising lowering cutting apparatus along one or more existing and intact guide lines on a running string from an above water location through the water to the guide post from which the disrupted guide line projects, the cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the upper end of the guide post from which the disrupted guide line projects, and effecting actuation of said cutting apparatus from the above water location to

cause said cutter means to sever the disrupted guide line above and closely adjacent to the top of the guide post.

4. In a method as defined in claim 3; wherein said cutting apparatus is lowered along at least two existing and intact guide lines.

5. In a method as defined in claim 3; said orienting of said cutting apparatus including engagement of said cutting apparatus with a reference member at the location of said guide post.

6. In a method as defined in claim 3; wherein said cutting apparatus is lowered along at least two existing and intact guide lines; said orienting of said cutting apparatus including engagement of said cutting apparatus with a reference member at the location of said guide post.

7. The method of reestablishing a disrupted guide line secured to and projecting from an underwater guide post, comprising lowering cutting apparatus on a running string from an above water location through the water to the guide post, said cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the point of exit of said guide line from the guide post, and effecting actuation of said cutting apparatus from the above water location to cause said cutter means to sever the guide line closely adjacent to the point of exit of said guide line from the guide post; lowering a connector secured to a replacement guide line on a running string through the water to the guide post, and securing said connector to said guide post.

8. In a method as defined in claim 7; lowering cutting apparatus on a running string through the water to the connector, and effecting actuation of said cutting apparatus from the above water location to sever the replacement guide line at the point of exit of said replacement guide line from the connector.

9. The method of reestablishing a disrupted guide line secured to and projecting from an underwater guide post, comprising lowering cutting apparatus on a running string from an above water location through the water to the guide post, said cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the point of exit of said guide line from the guide post, and effecting actuation of said cutting apparatus from the above water location to cause said cutter means to sever the guide line closely adjacent to the point of exit of said guide line from the guide post; releasably securing a connector to holding apparatus with a replacement guide line secured to said connector, lowering the holding apparatus on a running string through the water to place said connector over the guide post, securing said connector to said guide post with the replacement guide line extending upwardly therefrom, and releasing said holding apparatus from said connector.

10. In a method as defined in claim 9; lowering cutting apparatus on a running string through the water to the connector, and effecting actuation of said cutting apparatus from the above water location to sever the replacement guide line at the point of exit of said replacement guide line from the connector.

11. The method of severing a disrupted guide line secured to and projecting from the upper end of an un-

derwater guide post, comprising lowering cutting apparatus along one or more existing and intact guide lines on a running string from an above water location through the water to the guide post, the cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the upper end of the guide post, and effecting actuation of said cutting apparatus from the above water location to cause said cutter means to sever the disrupted guide line above and closely adjacent to the top of the guide post; releasably securing a connector to holding apparatus with a replacement guide line secured to said connector, lowering the holding apparatus along said one or more intact guide lines on a running string through the water to place said connector over the guide post, securing said connector to said guide post with the replacement guide line extending upwardly therefrom, and releasing said holding apparatus from said connector.

12. In a method as defined in claim 11; said orienting of said cutting apparatus including engagement of said cutting apparatus with a reference member at the location of said guide post.

13. In a method as defined in claim 11; lowering cutting apparatus on a running string through the water to the connector, and effecting actuation of said cutting apparatus from the above water location to sever the replacement guide line at the point of exit of said replacement guide line from the connector.

14. In a method as defined in claim 11; lowering cutting apparatus on a running string through the water to the connector, and effecting actuation of said cutting apparatus from the above water location to sever the replacement guide line at the point of exit of said replacement guide line from the connector, lowering releasing apparatus on a running string along said one or more intact guide lines through the water into coupling relation to said connector to release said connector from the guide post, and elevating said releasing apparatus on the running string to withdraw said connector from the guide post.

15. The method of severing a disrupted guide line secured to and projecting from the upper end of an underwater guide post, comprising lowering cutting apparatus along one or more existing and intact guide lines on a running string from an above water location through the water to the guide post, the cutting apparatus including guide line cutter means, orienting said cutting apparatus to place said cutter means closely adjacent to the upper end of the guide post, and effecting actuation of said cutting apparatus from the above water location to cause said cutter means to sever the disrupted guide line above and closely adjacent to the top of the guide post; wherein said cutting apparatus is lowered along at least two existing and intact guide lines; releasably securing a connector to holding apparatus with a replacement guide line secured to said connector, lowering the holding apparatus along at least two existing and intact guide lines on a running string through the water to place said connector over the guide post, securing said connector to said guide post with the replacement guide line extending upwardly therefrom, and releasing said holding apparatus from said connector.

16. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater guide post: a supporting structure; a cutting apparatus carried by said structure and including guide line cutter means; orienting means for placing said cutter means closely adjacent to the point of exit of the guide line from the guide post; said cutting apparatus further including means independent of said disrupted guide line and controlled from an above water location for actuating said cutter means to cause said cutter means to sever the disrupted guide line closely adjacent to the point of exit of the guide line from the guide post.

17. In apparatus as defined in claim 16; said orienting means including means engageable with the guide post.

18. In apparatus as defined in claim 16; and means for vertically adjusting said cutting apparatus on and with respect to said supporting structure.

19. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater guide post: a supporting structure; a cutting apparatus carried by said structure and including guide line cutter means; orienting means for placing said cutter means closely adjacent to the point of exit of the guide line from the guide post; said cutting apparatus further including means controlled from an above water location for actuating said cutter means to cause said cutter means to sever the guide line closely adjacent to the point of exit of the guide line from the guide post; said cutter means including cutting elements adapted to be located on opposite sides of the guide line; said actuating means shifting said cutting elements toward each other to sever the guide line.

20. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater guide post: a supporting structure; a cutting apparatus carried by said structure and including guide line cutter means; orienting means for placing said cutter means closely adjacent to the point of exit of the guide line from the guide post; said cutting apparatus further including means controlled from an above water location for actuating said cutter means to cause said cutter means to sever the guide line closely adjacent to the point of exit of the guide line from the guide post; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post.

21. In apparatus as defined in claim 19; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post to place said cutting elements on opposite sides of the disrupted guide line.

22. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater first guide post forming part of a guidance system including one or more existing and intact guide lines extending upwardly from one or more other guide posts: a supporting structure; cutting apparatus carried by said structure and including guide line cutter means; guide means carried by said structure and movable along the one or more intact guide lines during lowering of said structure through the water toward the first guide post and other guide posts; means on said structure for limiting its descent to thereby locate said cutter means closely adjacent to the point of exit of the disrupted guide line from the first guide post; said cutting apparatus further including means for actuating said

cutter means to cause said cutter means to sever the disrupted guide line closely adjacent to the point of exit of the disrupted guide line from the first guide post.

23. In apparatus as defined in claim 22; said cutter means including cutting elements adapted to be located on opposite sides of the guide line; said actuating means shifting said cutting elements toward each other to sever the guide line.

24. In apparatus as defined in claim 22; said cutter means including cutting elements adapted to be located on opposite sides of the guide line; said actuating means shifting said cutting elements toward each other to sever the guide line; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post to place said cutting elements on opposite sides of the disrupted guide line.

25. In apparatus as defined in claim 22; said cutter means including cutting elements adapted to be located on opposite sides of the guide line; said actuating means shifting said cutting elements toward each other to sever the guide line; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post to place said cutting elements on opposite sides of the disrupted guide line; said cutter means including means engageable with the first guide post for locating the cutting elements above and closely adjacent to the point of exit of the disrupted guide line from the first guide post.

26. In apparatus for connecting a guide line to an underwater guide post forming part of a guidance system: a supporting structure; holding apparatus carried by said structure; a connector having an external groove and the guide line secured thereto; said holding apparatus including means movable laterally inwardly into said external groove to releasably secure said connector to said holding apparatus and enable said connector to be lowered with said structure and holding apparatus through the water to place said connector over the exterior of the upper portion of the guide post; said connector having means thereon for releasably securing said connector to the guide post; and means for moving said holding apparatus means laterally outwardly from said groove to release said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and guide post.

27. In apparatus as defined in claim 26; and means for aligning said connector with the guide post to insure movement of said connector over the upper portion of said guide post.

28. In apparatus for connecting a guide line to an underwater guide post forming part of a guidance system: a supporting structure; holding apparatus carried by said structure; a connector having the guide line secured thereto and releasably secured to said holding apparatus to be lowered with said structure and holding apparatus through the water to place said connector over the upper portion of the guide post; said connector having means thereon for releasably securing said connector to the guide post; and means for releasing said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and guide post; the guide post having an external groove; the connector securing means including instrumentalities movable laterally in-

wardly into the groove to lock the connector to the guide post.

29. In apparatus as defined in claim 28; said connector further including holding means engaging said instrumentalities to prevent lateral outward movement of said instrumentalities from said groove.

30. In apparatus for connecting a first guide line to a first guide post forming part of a guidance system including one or more other guide lines extending upwardly from one or more other guide posts: a supporting structure; holding apparatus carried by said structure; a connector having an external groove and the first guide line secured thereto; said holding apparatus including means movable laterally inwardly into said external groove to releasably secure said connector to said holding apparatus; guide means carried by said structure and movable along said one or more other guide lines during lowering of said structure through the water toward the first guide post and other guide posts to guide said connector into alignment with and over the exterior of the upper portion of said first guide post; said connector having means thereon for releasably securing said connector to the first guide post; and means for moving said holding apparatus means laterally outwardly from said groove to release said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and first guide post.

31. In apparatus for connecting a first guide line to a first guide post forming part of a guidance system including one or more other guide lines extending upwardly from one or more other guide posts: a supporting structure; holding apparatus carried by said structure; a connector having the first guide line secured thereto and releasably secured to said holding apparatus; guide means carried by said structure and movable along said one or more other guide lines during lowering of said structure through the water toward the first guide post and other guide posts to guide said connector into alignment with and over the upper portion of said first guide post; said connector having means thereon for releasably securing said connector to the first guide post; and means for releasing said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and first guide post; the first guide post having an external groove; the connector securing means including instrumentalities movable laterally inwardly into the groove to lock the connector to the guide post.

32. In apparatus as defined in claim 31; said connector further including holding means engaging said instrumentalities to prevent lateral movement of said instrumentalities from said groove.

33. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater guide post: a supporting structure; a cutting apparatus carried by said structure and including guide line cutter means; orienting means for placing said cutter means closely adjacent to the point of exit of the guide line from the guide post; said cutting apparatus further including means controlled from an above water location for actuating said cutter means to cause said cutter means to sever the guide line closely adjacent to the point of exit of the guide line from the guide post; hold-

ing apparatus carried by said supporting structure; a connector having a replacement guide line secured thereto and releasably secured to said holding apparatus to be lowered with said structure and holding apparatus through the water to place said connector over the upper portion of the guide post; said connector having means thereon for releasably securing said connector to the guide post; and means for releasing said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and guide post.

34. In apparatus as defined in claim 33; said cutter means including cutting elements adapted to be located on opposite sides of the disrupted guide line; said actuating means shifting said cutting elements toward each other to sever the disrupted guide line; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post to place said cutting elements on opposite sides of the disrupted guide line.

35. In apparatus as defined in claim 33; the guide post having a groove; the connector securing means including instrumentalities movable laterally into the groove to lock the connector to the guide post.

36. In apparatus for reestablishing a disrupted guide line secured to and projecting from an underwater first guide post forming part of a guidance system including one or more existing and intact guide lines extending upwardly from one or more other guide posts: a supporting structure; cutting apparatus carried by said structure and including guide line cutter means; guide means carried by said structure and movable along the one or more intact guide lines during lowering of said structure through the water toward the first guide post and other guide posts; means on said structure for limiting its descent to thereby locate said cutter means closely adjacent to the point of exit of the disrupted guide line from the first guide post; said cutting apparatus further including means for actuating said cutter means to cause said cutter means to sever the disrupted guide line closely adjacent to the point of exit of the disrupted guide line from the first guide post; holding apparatus carried by said supporting structure; a connector having a replacement guide line secured thereto and releasably secured to said holding apparatus; said guide means carried by said structure moving along said one or more other guide lines during lowering of said structure through the water toward the first guide post and other guide posts guiding said connector into alignment with and over the upper portion of said first guide post; said connector having means thereon for releasably securing said connector to the first guide post; and means for releasing said holding apparatus from said connector to enable said supporting structure and holding apparatus to be elevated from the connector and first guide post.

37. In apparatus as defined in claim 36; said cutter means including cutting elements adapted to be located on opposite sides of the guide line; said actuating means shifting said cutting elements toward each other to sever the guide line; and means for shifting said cutting apparatus relative to said structure and laterally toward the guide post to place said cutting elements on opposite sides of the disrupted guide line.

38. In apparatus as defined in claim 36; the first guide post having a groove; the connector securing means including instrumentalities movable laterally into the groove to lock the connector to the first guide post.

39. In a connector for attachment to a companion member: body means adapted to be disposed over the companion member; lock means on said body means shiftable laterally inwardly of the companion member to couple said body means to the companion member; holding means engaging said lock means to maintain said lock means inwardly of the companion member; means movable laterally of said body means and holding means for retaining said holding means engaged with said lock means; and means for shifting said retaining means laterally of said body means and holding means to permit shifting of said holding means from its position maintaining said lock means inwardly of the companion member.

40. In a connector as defined in claim 39; and means movable over said body means into engagement with said releasing means to actuate said releasing means.

41. In a connector for attachment to a companion member: body means adapted to be disposed over the companion member; lock means on said body means shiftable laterally inwardly of the companion member to couple said body means to the companion member; holding means engaging said lock means to maintain said lock means inwardly of the companion member; means retaining said holding means engaged with said lock means; and means for releasing said retaining means to permit shifting of said holding means from its position maintaining said lock means inwardly of the companion member; said holding means comprising a sleeve shiftable relatively longitudinally of said body means to maintain said lock means inwardly of the companion member or to permit its outward movement relative thereto; said retaining means comprising means movable laterally of said body means and sleeve to and from its retaining position preventing or permitting longitudinal shifting of said sleeve relatively longitudinally of said body means; said releasing means engaging said laterally movable means.

42. In a connector for attachment to a companion member: body means adapted to be disposed over the companion member; lock means on said body means shiftable laterally inwardly of the companion member to couple said body means to the companion member; holding means engaging said lock means to maintain said lock means inwardly of the companion member; means retaining said holding means engaged with said lock means; and means for releasing said retaining means to permit shifting of said holding means from its position maintaining said lock means inwardly of the companion member; said lock means comprising a laterally contractable and expandable lock ring; said holding means comprising a sleeve shiftable relatively longitudinally of said body means to a position behind said ring to maintain said ring inwardly of the companion member or to a position removed from said lock ring to allow expansion of said ring from the companion member; said retaining means comprising a laterally contractable and expandable retainer ring; said releasing means comprising laterally movable means engaging said retainer ring.

43. In a connector as defined in claim 41; and means movable over said body means into engagement with said laterally movable means to actuate said laterally movable means.

44. In a connector for attachment to a guide post having an external groove: a body structure movable over the guide post; laterally movable lock means on said body structure movable into and from the groove to couple the body structure to the guide post; a holding sleeve shiftable relatively longitudinally of said body structure to and from a position behind said lock means to retain said lock means in the groove or to permit its withdrawal therefrom; laterally movable coengageable retainer means on said body structure and sleeve for retaining said sleeve behind said lock means; and means for shifting said retainer means laterally to disengage said retaining means and permit said sleeve to shift relatively longitudinally of said body structure from its position behind said lock means.

45. In a connector for attachment to a guide post having an external groove: a body structure movable over the guide post; laterally movable lock means on said body structure movable into and from the groove to couple the body structure to the guide post; a holding sleeve shiftable relatively longitudinally of said body structure to and from a position behind said lock means to retain said lock means in the groove or to permit its withdrawal therefrom; coengageable retainer means on said body structure and sleeve for retaining said sleeve behind said lock means; and means for disengaging said retaining means to permit said sleeve to shift relatively longitudinally of said body structure

from its position behind said lock means; said lock means comprising a laterally contractable and expandable lock ring; said retainer means comprising a laterally contractable and expandable retainer ring.

46. In a connector for attachment to a guide post having an external groove: a body structure movable over the guide post; laterally movable lock means on said body structure movable into and from the groove to couple the body structure to the guide post; a holding sleeve shiftable relatively longitudinally of said body structure to and from a position behind said lock means to retain said lock means in the groove or to permit its withdrawal therefrom; coengageable retainer means on said body structure and sleeve for retaining said sleeve behind said lock means; and means for disengaging said retaining means to permit said sleeve to shift relatively longitudinally of said body structure from its position behind said lock means; said lock means comprising a laterally contractable and expandable lock ring; said retainer means comprising a groove in said sleeve and a laterally contractable and expandable retainer ring on said body structure shiftable laterally into and from said sleeve groove; said disengaging means comprising laterally movable elements carried by said body structure and engaging said retainer ring and projecting from said body structure.

47. In a connector as defined in claim 46; and means movable over said body structure into engagement with said projecting elements to shift said elements laterally inwardly of said body structure to shift said retainer ring from said sleeve groove.

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