Jan. 7, 1969 S. W. PUTCH 3,420,308

WELL CASING HANGER

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FIG_1

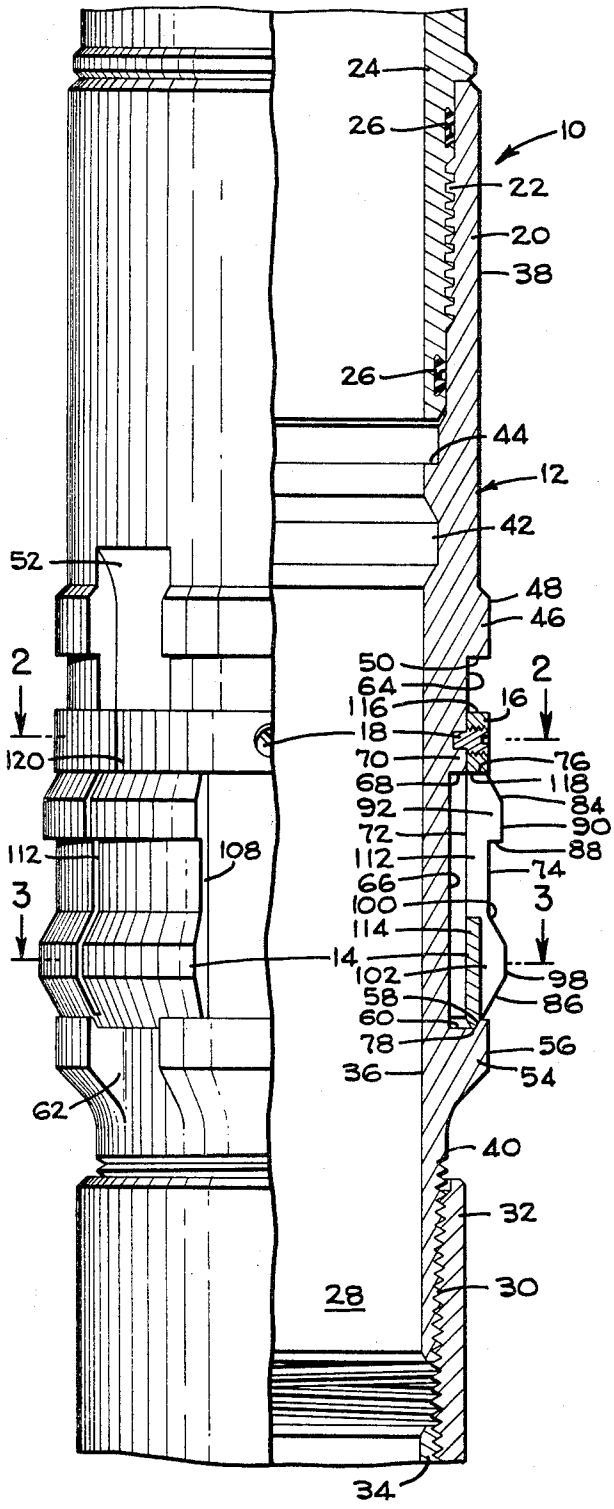


FIG_2

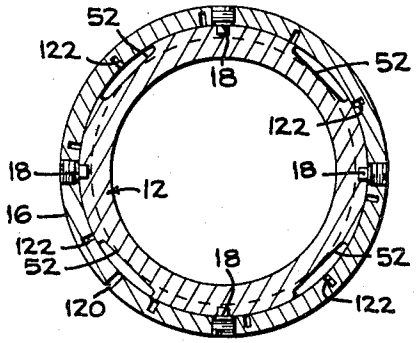
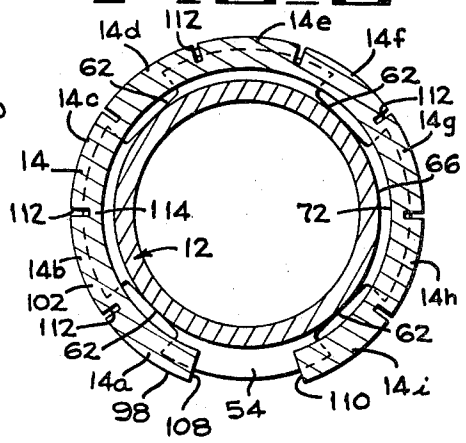


FIG_3



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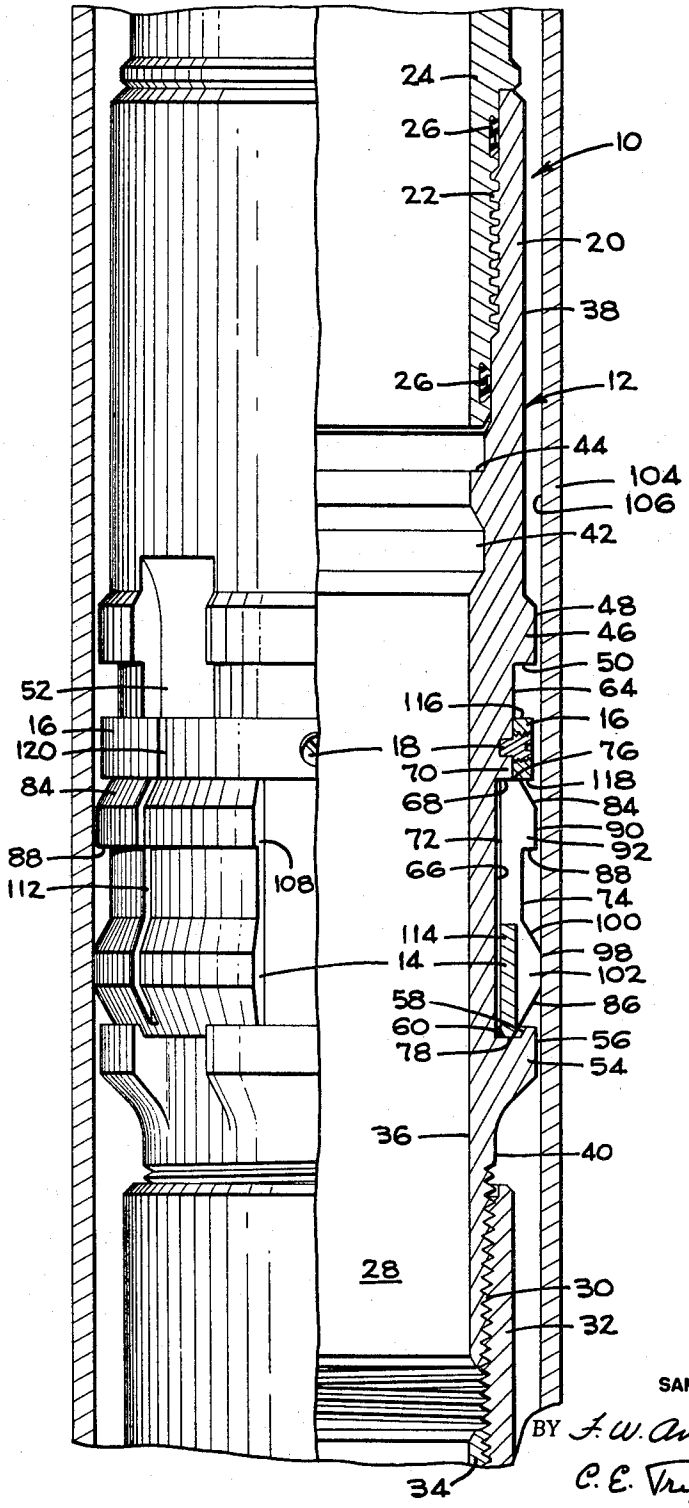
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WELL CASING HANGER

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FIG_4



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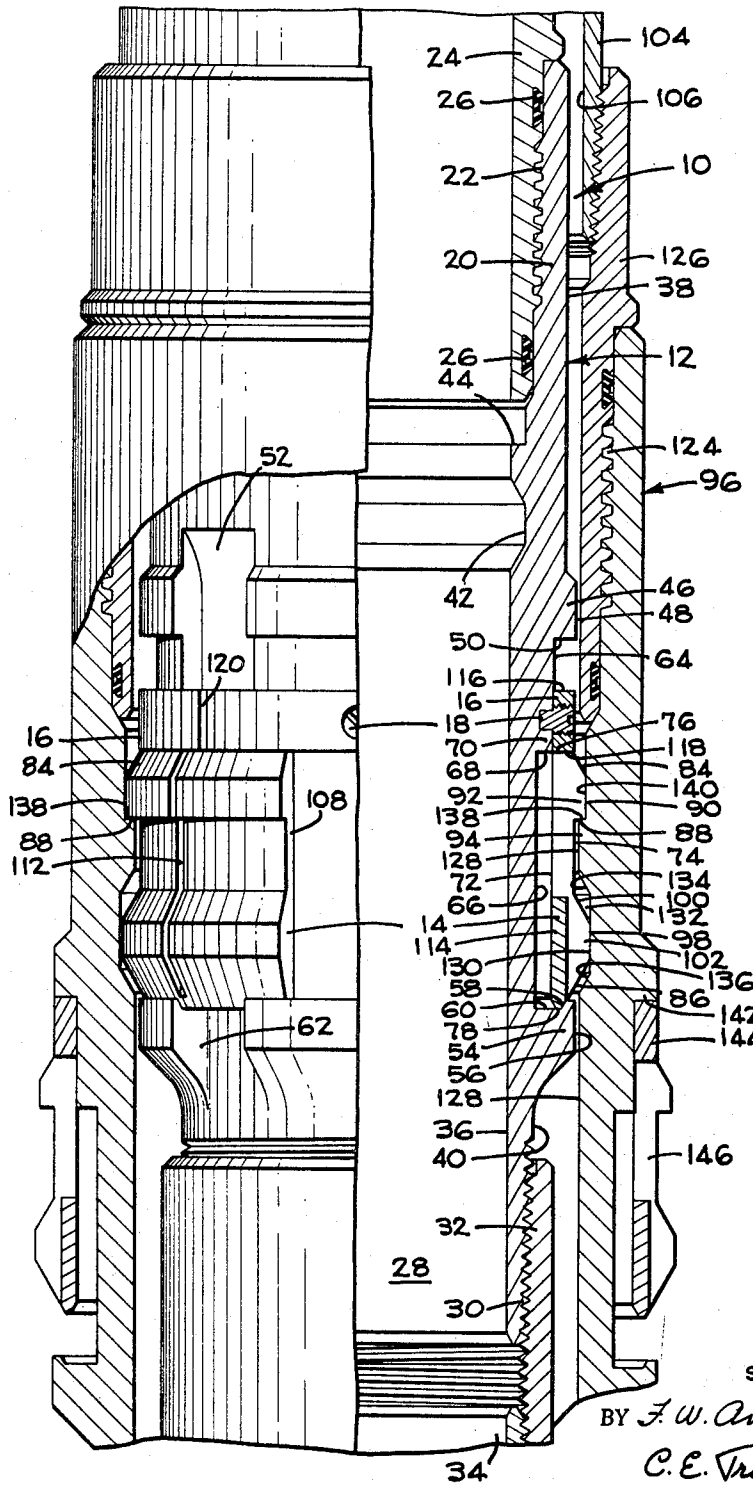
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WELL CASING HANGER

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FIG_5



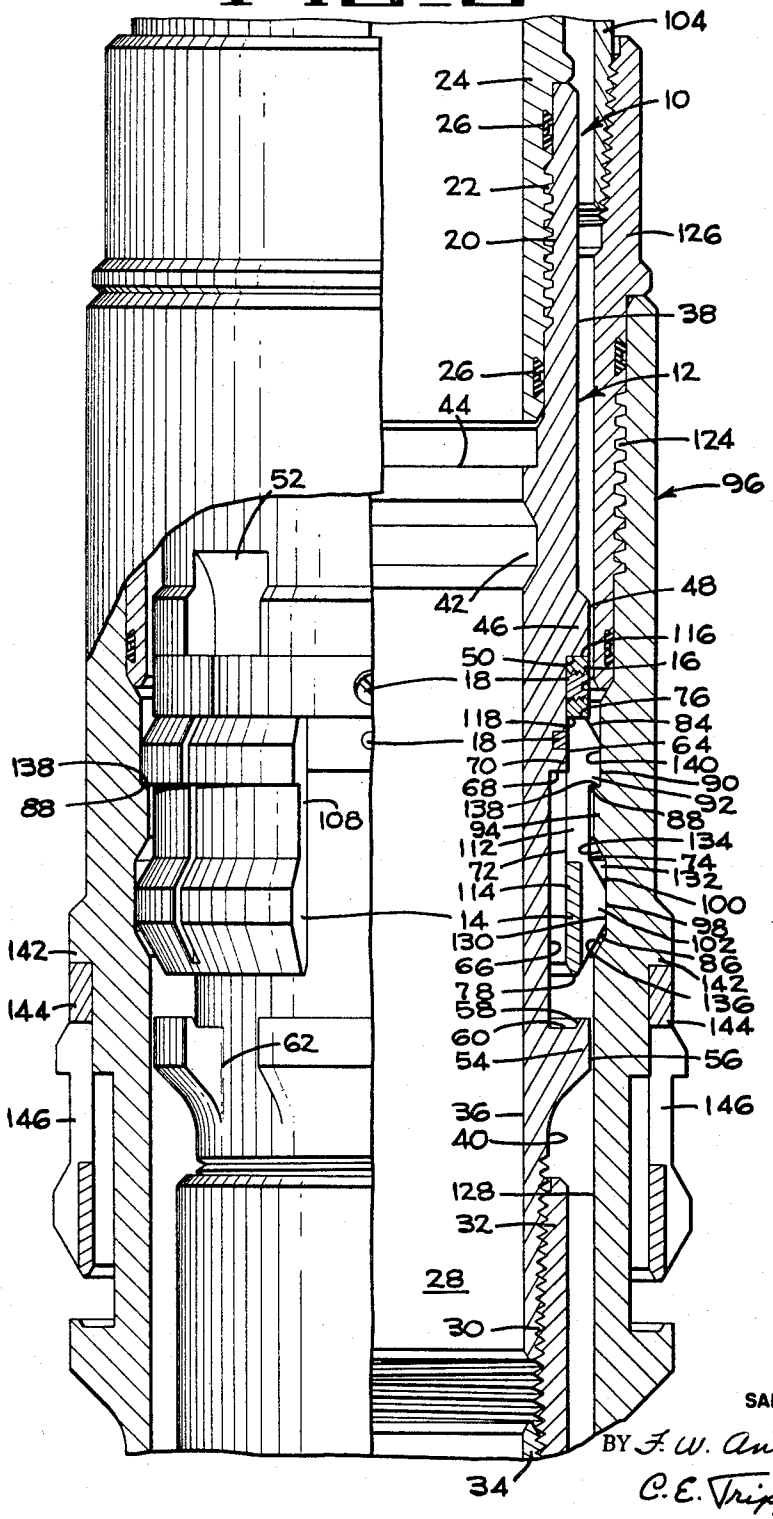
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WELL CASING HANGER

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FIG_6



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WELL CASING HANGER

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U.S. Cl. 166—208 7 Claims

Int. Cl. E21b *17/046*

ABSTRACT OF THE DISCLOSURE

A well casing hanger for suspending an inner string of well casing at a predetermined location in an outer casing string, including a resilient self-expanding annular ring that automatically engages a cooperating hanger coupling prepositioned in the outer casing, and a flow-conducting body that locks the ring in its expanded condition, the hanger thereby preventing further movement of the inner casing downward and accommodating retraction of the resilient ring upon upward movement of the hanger in the outer casing.

Background of the invention

The field of art to which this invention pertains includes devices for suspending pipe or casing in wells or shafts bored into the earth, and more particularly to such devices for suspending an inner casing at a predetermined position inside an outer casing. More particularly, the invention relates to devices commonly known as casing hangers, and to those hangers which include an expansible and contractible element adapted to expand into a predesignated section of the outer casing to preclude downward travel of the inner casing within the outer casing.

In the practice of drilling wells for the recovery of valuable fluids such as oil and gas, it is customary to line the well bore with a series of concentric pipes, called casing strings, suspended from the top of the well by a hanger device that fastens an inner casing to the next adjacent outer casing. Where wells are drilled in off-shore locations, and particularly in deep water, it has been found desirable to support the several casing strings at the ocean floor to take advantage of the earth's lateral and vertical support, rather than at the water's surface which leaves the casing highly susceptible to damage or loss as a result of surface storms, tidal fluctuations, strong currents, and sometimes just the great weight itself of an extensive length of heavy pipe. To overcome this problem, hangers that can be positioned at any desired place in an outer casing string have been developed to suspend the inner casing string at any level in the well, including at the ocean floor.

Although in general these hangers operate satisfactorily, many contain a plurality of spring-biased locking elements that are expanded into the landing section of the outer casing to secure the inner casing to it, and these springs can break or otherwise fail to perform. Another problem with hangers of this type is that they usually contain a number of parts which are rather intricate and therefore expensive. Further, the more complex the hanger the greater chance there is for it to malfunction, requiring a halt in well operations until the problem is corrected. Applicant's present invention is designed to overcome each of these problems, and in so doing provides a new type of hanger that has fewer parts, is simpler to operate, and is less susceptible to malfunction than prior devices for this purpose.

Summary of the invention

Broadly considered, applicant's invention comprises a hanger for connecting an inner pipe or casing to an outer concentric pipe or casing at a pre-designated location to prevent further downward movement of the inner casing in the outer casing, but permit upward movement of the inner casing with respect to the outercasing, and includes a tubular hanger body adapted for connecting to the upper end of the inner casing, a self-expandable hanger ring surrounding the hanger body and retained on it by a system of upper and lower stops, and a shear ring and pin assembly that responds to the weight of the casing to allow the hanger body to lock the hanger ring in its expanded condition. The hanger cooperates with a hanger coupling that can be positioned in the outer casing at any desired level, the hanger ring being resiliently retracted and having an outer configuration complementary to the inner configuration of the hanger coupling. Thus when the inner casing is lowered through the outer casing and the hanger ring comes into position opposite the hanger coupling, the ring automatically expands into the coupling without further manipulation. The shear ring and pin assembly retains the hanger ring in proper position on the hanger body while the hanger is being lowered in the outer casing, and includes a shear ring circumscribing the hanger body above the hanger ring, and a plurality of frangible shear pins that releasably secure the shear ring to the hanger body. The pins are severed by the shear ring when the weight of the inner pipe is allowed to bear on it, thereby permitting the shear ring and the hanger ring to move upwardly on the hanger body into a final locked position preventing further downward movement of the inner casing. However, from this position the inner casing can be moved upwardly, and in fact withdrawn from the outer casing, simply by lifting up on the hanger body, thereby causing the hanger ring to move back to its former position on the body where it can contract as restrictions in the outer casing are encountered and allow the inner casing to continue its upward travel. Applicant's casing hanger thus provides all of the desirable functions and the advantages of the prior devices for this purpose without several of the more aggravating disadvantages thereof.

Brief description of the drawings

FIGURE 1 is a view in side elevation, and partially broken away, of the casing hanger of this invention, connected at its lower end to a string of well casing and at its upper end to a conventional running string.

FIGURE 2 is a view in section, taken along the line 2—2 of FIGURE 1, through the shear ring and the hanger body.

FIGURE 3 is a view in section, taken along the line 3—3 of FIGURE 1, through the hanger ring and the hanger body.

FIGURE 4 is a view in side elevation, and partially broken away, showing the casing hanger of FIGURE 1 as it is being lowered in an outer concentric casing string.

FIGURE 5 is a view in side elevation, and partially broken away, showing the hanger after it has reached the hanger coupling in the outer casing string of FIGURE 4.

FIGURE 6 is a view similar to FIGURE 5, but illustrating the hanger in its subsequent locked position in the hanger coupling.

Description of the preferred embodiments

Referring now to the drawings, the casing hanger **10** of the present invention includes a tubular body **12**, a resiliently expandable and contractible hanger ring **14** circumscribing the body **12**, a shear ring **16** above the hanger ring **14** and circumscribing the body **12**, and a

plurality of frangible shear pins **18** that releasably hold the shear ring **16** in position on the body **12**. The upper portion **20** of the body **12** is provided with an internal set of acme threads **22** for connecting the casing hanger **10** to a running string (not shown) through a landing sub **24**, this connection being fluid tight by virtue of the seals **26**. The lower portion **28** of the hanger body **12** is provided with external threads **30** to facilitate joining the body **12** through a coupling **32** to the upper end of a casing string **34**.

The hanger body **12** has an inner cylindrical surface **36**, an upper outer cylindrical surface **38**, and a lower outer cylindrical surface **40** of lesser diameter than the surface **38**. In its preferred form, the inner surface **36** has an annular groove **42**, and is relieved above the groove **42** to form an upwardly-facing stop shoulder **44**, the groove **42** and shoulder **44** providing landing means for suspending another string of casing inside the hanger body **12** with another hanger of this type. It is to be understood that the inner surface **36** may be provided with other configurations, or may have no grooves or shoulders, as desired.

The upper outer surface **38** of the hanger body **12** is provided with an upper stop shoulder **46** having an outer cylindrical surface **48** and a downwardly facing radial shoulder surface **50** for contacting the shear ring **16** and preventing further downward movement of the body **12** therein, the shoulder **46** being separated into a plurality of segments by axially extending grooves **52** in the surface **38**. Projecting outwardly from the hanger body's lower outer surface **40** is a lower stop shoulder **54** for retaining the hanger ring **14** on the body **12**, the shoulder **54** having an outer cylindrical surface **56**, an upwardly facing, inverted generally conical surface **58**, and an inner, upwardly facing radial shoulder surface **60**, the shoulder **54** likewise being divided into a plurality of segments by grooves **62**.

Extending downwardly from the upper stop shoulder **46** is a cylindrical locking surface **64** that serves to lock the hanger ring **14** in its fully expanded condition, and extending upwardly from the lower stop shoulder **54** is another cylindrical surface **66**. A radially-extending surface **68** joins the two surfaces **64**, **66**, providing a stop **70** that prevents the hanger ring **14** from being accidentally forced upwardly on the hanger body **12** as it is being lowered through the outer casing.

The hanger ring **14** has an inner cylindrical surface **72**, an outer cylindrical surface **74**, and upper and lower annular end surfaces **76**, **78**, respectively.

The outer edges of the upper and lower ends of the ring **14** are beveled to provide camming surfaces **84**, **86** for retracting the ring **14** when it encounters obstructions as the hanger **10** is moving through an outer casing. Extending outwardly from the upper end of the outer cylindrical surface **74** is a downwardly facing annular radial shoulder surface **88** that, in combination with the cylindrical surface **90**, provides a stop shoulder **92** which cooperates with an upwardly facing surface **138** of the stop shoulder **94** (FIGS. 5 and 6) in a hanger coupling **96** to preclude further downward movement of the hanger ring **14** in the coupling.

The lower portion of the hanger ring **14** has an outer cylindrical surface **98** and a downwardly and outwardly-extending upper surface **100** that, together with the lower beveled surface **86**, form an annular boss **102**. The boss **102** prevents the hanger ring **14** from expanding into a groove or other relieved area in the outer casing until the ring is properly positioned in the hanger coupling **96**, as shown in FIGURE 5. The diameter of the cylindrical surface **98** is greater than that of the cylindrical surface **90** of the shoulder **92**, and as a result when the hanger **10** is within an outer casing **104** (FIGURE 4) only the surface **98** is in contact with the outer casing's inner surface **106**.

The hanger ring **14** is split axially throughout its length, and therefore has axially extending opposed surfaces **108**, **110**, as is perhaps best illustrated in FIGURE 3. The ring **14** also is divided into a plurality of rigid segments **14***a*, *b*, *c*, etc. (FIG. 3), by a plurality of axial slots **112**, but has an annular web **114** that joins the several segments together. The web **114** is dimensioned to permit the ring **14** to expand and contract as required for passing obstructions in the outer casing as well as for proper seating of the ring in the hanger coupling.

When in its rest position as illustrated in FIGURES 1, 2, 4 and 5, the shear ring **16** is mounted on the locking surface **64** of the hanger body **12** immediately above the hanger ring **14** through frangible shear pins **18** that preclude axial movement of the shear ring **16** on the body **12**. The shear ring **16** has upper and lower annular radially-extending surfaces **116**, **118**, respectively, the surface **118** functioning as a stop for preventing the hanger ring **14** from moving toward the upper portion **20** of the hanger body **12**. When the casing hanger **10** is fully set and locked, as shown in FIGURE 6, the surface **116** bears against the radial surface **50** of the upper stop shoulder **46**, so that the forces tending to move the hanger **10** and the inner pipe **34** further downwardly are transferred through the shear ring **16** to the hanger ring **14**, and thence to the hanger coupling **96** in a secure, positive manner. As shown best in FIGURE 2, the shear ring **16** is axially split at **120** and is provided with a plurality of inner axially extending slots **122**, for imparting the resilient expandability and contractibility required to install the ring on the hanger body **12** by slipping it over the shoulder **46**.

As illustrated in FIGURES 5 and 6, a hanger coupling **96** connected at the desired level into the outer casing **104** provides a landing device for suspending the inner casing **34** in the outer casing. The upper end of the hanger coupling **96** preferably has acme threads **124** to releasably join it to a landing sub **126** which, in turn, is threaded at its upper end into the outer casing **104**. The internal cylindrical surface **128** of the hanger coupling **96** has an annular groove **130** with an axially extending cylindrical surface **132** and upper and lower inwardly diverging end surfaces **134**, **136**, respectively. Above the groove **130** a radial surface **138** extends outwardly from the cylindrical surface **128** to another cylindrical surface **140**.

Also, as shown in FIGURES 5 and 6, if it is desired to suspend the outer casing **104** in still another casing of larger diameter (not shown), the hanger coupling **96** may be provided with a stop shoulder **142**, a shear ring **144**, and a hanger ring **146**, all analogous to the corresponding elements of the hanger **10**, i.e., the hanger coupling **96** may be shaped like casing hanger **10**, but of larger diameter. Of course, it should be understood that the hanger coupling **96** needs only an internal configuration that will cooperate with the hanger **10** and hold it securely, so that hanger couplings other than the type illustrated at **96** are also within the scope of this invention.

As is apparent from the foregoing description, suspending a string of inner casing in an outer casing with the hanger **10** involves merely lowering the hanger and the inner casing in the outer casing, i.e., no rotation or other manipulation procedures are required. As explained previously, while the hanger **10** and the inner casing **34** are being lowered the cylindrical surface **98** of the hanger ring **14** remains against the inner surface **106** of the outer casing **104**, as illustrated in FIGURE 4, holding the hanger ring **14** sufficiently retracted to prevent its shoulder **92** from contacting restrictions that might be present in the outer casing and stopping the downward travel of the inner casing and hanger. As the hanger **10** reaches the level illustrated in FIGURE 5, the hanger ring **14** expands into the coupling **96**, the boss **102** entering the coupling groove **130** and the stop shoulder **92** moving outwardly toward the coupling's inner cylindrical surface **140**. When the hanger ring **14** is expanded fully (FIGURE 5), its cylindrical surfaces **90**, **98** bear against

the coupling's cylindrical surfaces **140**, **132**, respectively, its entire radial end surface **76** is beyond the coupling's stop shoulder **70**, and the surface **88** of its stop shoulder **92** extends over the radial surface **138** of the coupling's stop shoulder **94**.

The holding tension on the running string is then relaxed, transferring the weight of the inner casing string **34** to the coupling **96** through the shear ring **16** and hanger ring **14**. This shears the pins **18** and pulls the hanger body **12** downwardly within the shear ring **16** until the radial surface **50** of the hanger body stop shoulder **46** comes to rest on the shear ring's upper surface **116**, as is illustrated in FIGURE 6. Simultaneously, the shoulder **70** and the locking surface **64** of the hanger body **12** move down inside the hanger ring **14**, preventing the ring **14** from retracting and releasing its grip on the hanger coupling. Thus, in the condition shown in FIGURE 6, the hanger **10** is set and locked in the coupling **96** to suspend the casing **34** from that point.

Although setting and locking the hanger **10** in the coupling **96** precludes further downward movement of the hanger and its attached inner casing **34**, one of the advantages of this invention is that the hanger and inner casing can be raised out of the coupling **96** and the outer casing simply by lifting on the hanger body **12**. As the body **12** moves upwardly and the first restriction is encountered by either of the hanger ring's beveled surfaces **84**, **100**, such as when the upper surface **134** of the hanger coupling's groove **130** is encountered by the surface **100**, the hanger ring **14** is held by the restriction until the lower stop shoulder **54** contacts the ring's lower end surface **78**. The ring **14** then continues upwardly with the body **12**, and in doing so retracts inwardly in response to the camming action of the beveled surface that is bearing against the restriction. In similar manner the beveled surfaces **84**, **100** cam the ring **14** past subsequent restrictions in the outer pipe. Thus neither rotation nor any other procedure except lifting is required to withdraw the hanger **10** from its coupling.

Once the inner pipe is hung (FIG. 6), the running string is rotated to back the landing sub **24** out of the hanger body **12**, and then lifted from the well. Other well operations then can be conducted in the conventional manner, including lowering and setting another string of casing within the inner casing **34** by using the hanged body **12** with its groove **42** and stop shoulder **44** as the coupling. When it is desired to remove the inner casing **34**, a running string with a landing sub is lowered, rotated in the opposite direction to connect the sub to the hanger body **12**, and then lifted back out, bringing the hanger **10** and the inner casing **34** with it.

The casing hanger **10** can be employed to suspend casing at any desired location in the well merely by properly positioning the cooperating hanger coupling **96**. For example, this hanger is ideally suited for on-bottom suspension of the casing in an underwater well where there is adequate support so that the surface conductor, which extends from the ocean floor to the surface of the water, does not have to bear the weight of the inner strings of casing and thus is not subjected to undue compressive load. The hanger also serves unusually well for suspending casing strings in a telescoping manner, i.e., each string suspended from the bottom of its immediately adjacent outer string, thereby reducing casing expense. Since no slips are used in this hanger, the attendant disadvantages thereof, such as casing distortion, are avoided. Conventional cementing procedures can be carried out through this hanger, the slots **52** and **62** providing ample fluid bypasses.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention as set forth in the appended claims.

I claim:

1. A pipe hanger assembly for suspending an inner pipe within and from an outer pipe, comprising: an elongated tubular hanger body with upper and lower ends, said upper end adapted for releasable connection to a well tool and said lower end adapted for connection to a pipe, upper stop means extending outwardly from the outer surface of said hanger body intermediate said ends, lower stop means extending outwardly from the outer surface of said hanger body intermediate said upper stop means and said lower end, a resiliently expandable and contractible hanger locking ring circumscribing said hanger body and axially slidable thereon between said upper and lower stop means, said ring adapted for self-movement from a contracted condition into an expanded condition to preclude downward movement of said hanger body in said outer pipe while facilitating upward movement of said hanger body therein; locking means on the outer surface of said hanger body intermediate said upper and lower stop means and adapted to lock said hanger locking ring in its expanded condition, and releasable stop means on the outer surface of said hanger body intermediate said upper stop means and said locking ring for preventing said locking means from locking said locking ring in said expanded condition.

2. The pipe hanger assembly of claim **1** wherein said hanger locking ring is split axially and is provided with a lower outwardly-extending annular boss and an upper outwardly-extending annular locking shoulder.

3. The pipe hanger assembly of claim **2** wherein said annular boss has a larger outside diameter than said annular locking shoulder, for providing a bearing surface for said locking ring with respect to said outer pipe.

4. The pipe hanger assembly of claim **3** wherein said locking ring is divided into a plurality of rigid axially extending segments by a plurality of axial slots.

5. The pipe hanger assembly of claim **4** wherein said locking means comprises a cylindrical locking surface extending from said upper stop means towards said lower stop means, and having a diameter sufficient to hold said locking ring in expanded locking condition with respect to said outer pipe when said ring is circumscribing said surface.

6. The pipe hanger assembly of claim **5** wherein said releasable stop means comprises an annular shear ring circumscribing said locking surface and releasably secured thereto by frangible shear pins.

7. The pipe hanger assembly of claim **6** wherein said lower stop means includes an outer axially extending retainer flange for retaining said locking ring in position on said hanger body.

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U.S. Cl. X.R.

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