Aug. 26, 1958 R. O. PARK 2,849,071

CASING CENTRALIZERS

Filed July 30, 1956

2 Sheets-Sheet 1

FIG. 1.

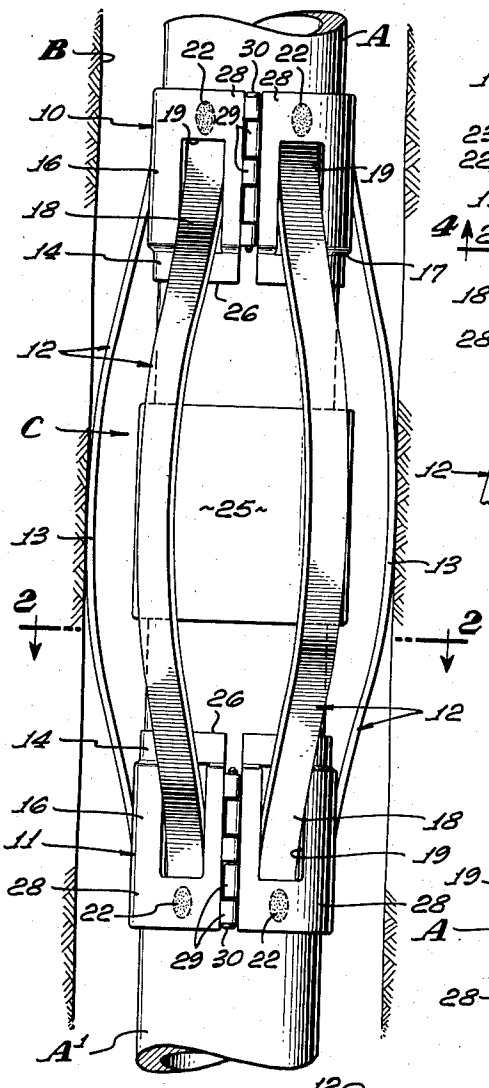

FIG. 3.

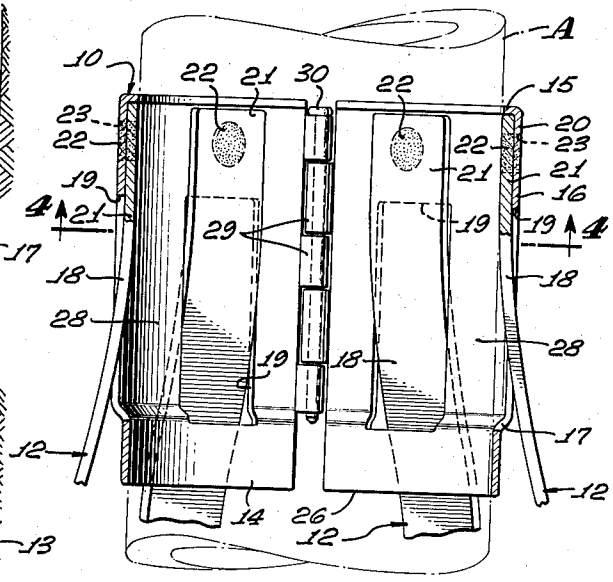

FIG. 4.

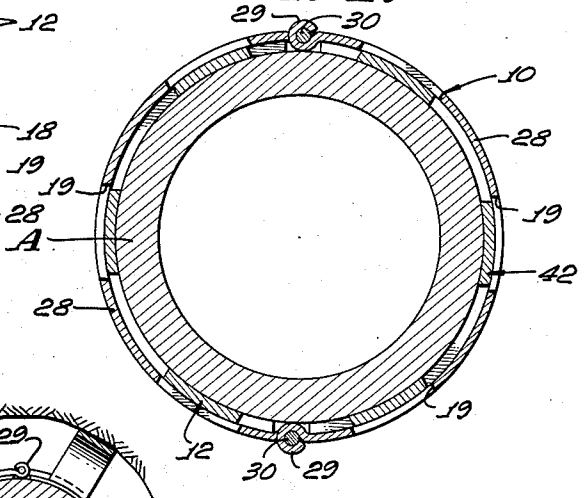

FIG. 2.

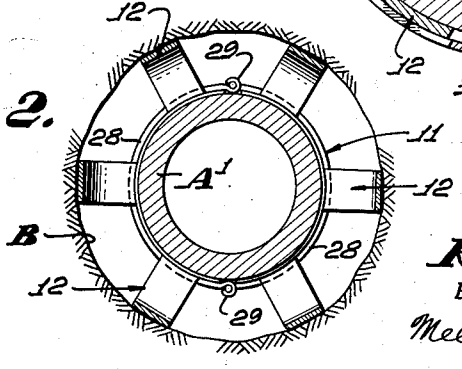

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FIG. 5.

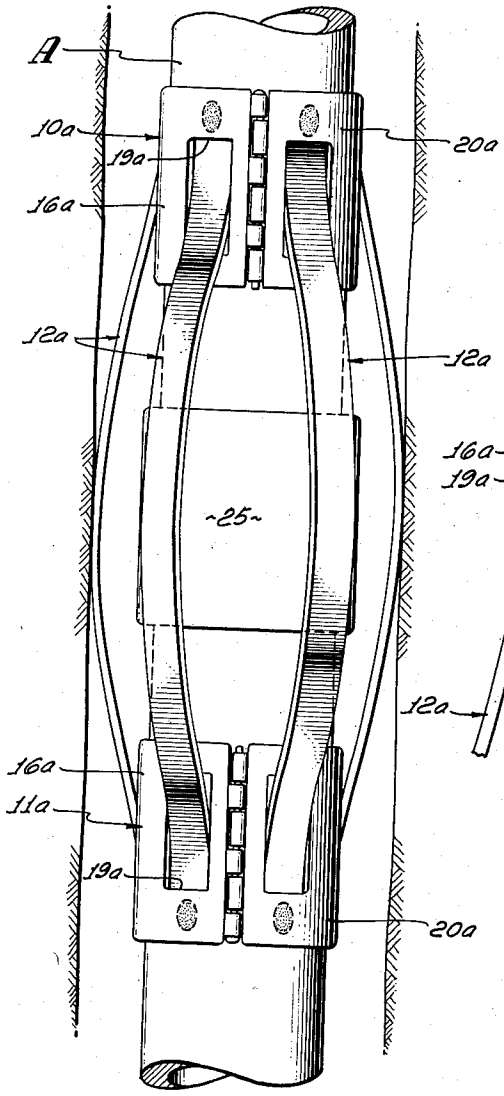
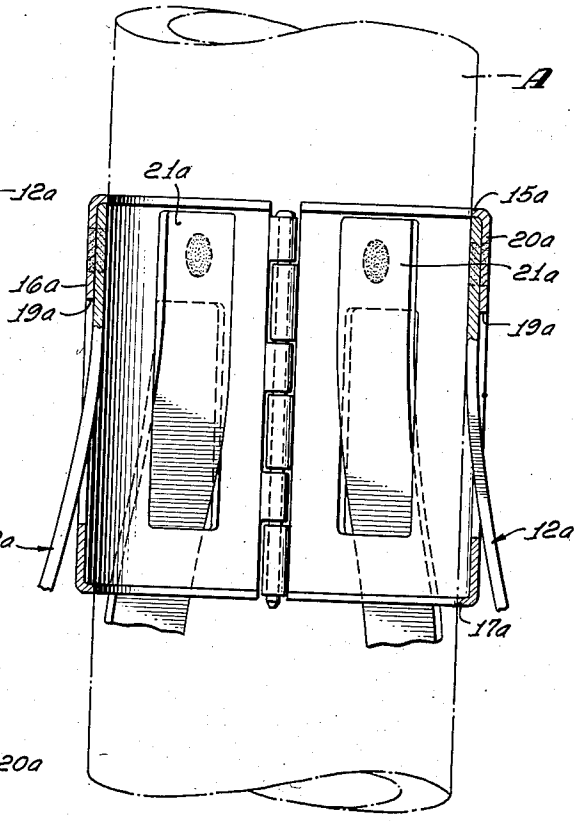


FIG. 6.



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United States Patent Office 2,849,071 Patented Aug. 26, 1958

2,849,071

CASING CENTRALIZERS

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Application July 30, 1956, Serial No. 600,913

6 Claims. (Cl. 166—241)

The present invention relates to apparatus for centering casing and similar conduits in well bores.

This application is a continuation-in-part of my application for "Casing Centralizer," Serial No. 528,576, filed August 16, 1955, now abandoned.

An object of the invention is to provide centralizers to be mounted on conduit strings positionable in well bores, embodying outwardly bowed springs welded to and arranged on collars in such manner as to minimize the chance of spring failure at their welded locations, and to reduce the diameter of the centralizers when the springs are in their fully collapsed position against the conduit string, thereby enabling the centralizers to be run through close clearance surface casing.

Another object of the invention is to provide casing centralizers that are economical to manufacture, of strong and sturdy construction, and of a reduced over-all diameter when the outwardly bowed springs of the centralizers are collapsed substantially fully against the casing on which the centralizers are mounted.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms 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, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation of a centralizer mounted on casing disposed in a well bore;

Fig. 2 is a cross-section taken along the line 2—2 on Fig. 1;

Fig. 3 is an enlarged side elevational and sectional view of the upper portion of the centralizer;

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 3;

Fig. 5 is a side elevation corresponding to Fig. 1 of a modified form of centralizer;

Fig. 6 is an enlarged side elevational and sectional view of the upper portion of the centralizer shown in Fig. 5.

As disclosed in Figs. 1 to 4 of the drawings, a string of well casing A, or similar conduit string, is to be maintained in a substantially centered location within a well bore B. To achieve this purpose, a casing centralizer apparatus C is mounted on the casing string. This centralizer device includes longitudinally spaced upper and lower collars 10, 11, or generally cylindrical members, that are preferably slidably mounted on the casing. Circumferentially spaced, outwardly bowed springs 12 extend between and are secured to these collars, the medial portions 13 of the springs engaging the wall of the well bore B. Because of the force that the springs 12 exert against

the wall of the well bore, they tend to position and maintain the casing string A in a substantially central location within the well bore.

The upper and lower portions of the centralizer are essentially the same, although oppositely disposed. The upper collar 10 is in the form of a generally cylindrical member, which may be made of sheet metal for purposes of economy in production. A relatively light gauge of sheet metal may be provided. The inner portion 14 of the collar is of a diameter that is slightly greater than the outside diameter of the casing A, in order that the collar will slidably fit the casing section on which it is mounted. The collar also has an outer inturned flange 15 of an internal diameter substantially the same as the internal diameter of the inner portion 14 of the collar. Such flange also will slide along the casing A and serve to maintain the collar 10 in proper relation on the casing.

Between the inner, generally cylindrical portion 14 and outer inturned flange 15 of the collar, the latter is formed with an intermediate collar portion 16 which has an internal diameter that is greater than the internal diameter of the inner collar portion 14 by an amount that is substantially equal to twice the thickness of an outwardly bowed spring 12. Actually, the outermost end of the intermediate collar portion 16 is integral with and merges into the outer inturned flange 15, whereas the inner end of the intermediate collar portion 16 is connected to the inner part 14 of the collar by an inturned flange 17, this latter flange being integral with both the intermediate portion and the inner portion of the collar. In effect, the intermediate portion 16 of the collar may be considered as constituting the web portion of a relatively long and shallow channel section that is integral with upper and lower inturned flanges 15, 17. Inasmuch as the collar 10 is made from sheet metal, the thicknesses of the inturned flanges 15, 17, intermediate web portion 16 and inner portion 14 are substantially the same and uniform.

The outwardly bowed springs 12 are arranged circumferentially around the collars 10, 11 and are spaced from each other preferably by equal amounts. The upper portion 18 of each spring extends through an elongate slot 19 in the intermediate collar portion 16, this slot being of slightly greater width than the width of the spring. It may extend from the lower inturned flange 17 to the upper region 20 of the intermediate portion of the collar 16, this upper region being continuous in an arcuate direction. The terminal portion 21 of each spring is relatively flat and substantially parallel to the axis of the centralizer. This terminal portion extends along the inner wall of the continuous section 20 of the intermediate collar portion, its outermost end being closely adjacent the outer inturned flange 15. As a matter of fact, the end of the spring may actually abut the outer inturned flange 15. The terminal 21 of the spring is secured to the collar by the use of welding material 22. Thus, the terminal portion of the spring may be spot welded to the continuous section 20 of the collar, with the spring lying flat against the inner wall of the collar section 20. However, to more securely integrate each spring to the collar, the latter may be provided with a hole 23 overlying the end 21 of the spring, the latter being secured to the continuous collar section 20 by means of a plug weld 22 run around the circumferential portion of the hole 23 and integrating the spring to the continuous section of the collar itself.

As was stated above, the upper and lower portions of the centralizer are alike although oppositely disposed. The lower ends 18 of the springs extend through the collar slots 19, the lower portions being plug welded or spot welded to the continuous section 20 of the collar

11, the springs lying flat against the inner wall of this lower continuous section 20.

The centralizer C is mounted upon a casing section A, there being a suitable annular stop member 25 secured to the casing section between the inner portions 14 of the collars 10, 11. This stop member 25 is adapted to engage with the innermost edges 26 of the collars. Originally, the distance across the intermediate portions 13 of the centralizer springs is substantially greater than the diameter of the well bore B, so that the insertion of the casing in the well bore will cause the springs to be collapsed inwardly to a partial extent, pushing against the wall of the formation and tending to locate the casing A in a substantially centered position within the bore B. During the lowering of the string of well casing in the well bore, the annular stop member 25 will engage the inner edge 26 of the inner collar portion 14 of the lower collar 11, and exert a pulling action on the centralizer, forcing it downwardly in the well bore with the casing on which the centralizer is mounted, the intermediate portions 13 of the springs sliding along the wall of the hole. If a restriction in the well bore is encountered, the annular stop ring 25 will still engage and exert a downward force on the lower collar 11, causing the latter to pull the springs past the obstruction, the springs merely being forced inwardly to a greater extent until the centralizer has moved beyond the obstruction. The downward force is transmitted from the collar 11, through the welds 22, to the springs 12, the welds having more than adequate strength to safely carry the loads imposed upon them.

As the springs 12 are urged inwardly by the wall of the formation or by a restriction encountered therein, their upper and lower portions 18 will be forced against the exterior of the casing A on which the centralizer is mounted, inasmuch as the slots 19 through which the outer portions of the springs extend into the collars are of an elongated extent. As the outer portions 18 of the springs bear upon the casing A, when the intermediate parts 13 of the springs are urged inwardly by the wall of the hole or the formation, they tend to shift the terminal portions 21 of the springs in an outward direction. The force accompanying such outward shifting tendency is not imposed upon the welds 22, but is transferred from terminal portions in an outward direction directly to the continuous section 20 of each collar. Accordingly, it is evident that substantially the only loads that the welds are required to carry is a pulling load, necessary to move the centralizer springs 12 longitudinally along the wall of the well bore.

The above action occurs upon movement of the casing string in both directions. Thus, if the casing string A were to be elevated instead of being lowered, as described above, the stop ring 25 would engage the innermost edge 26 of the upper collar 10, shifting the latter in an upward direction and moving the springs 12 in an upward direction through the agency of the upper plug welds 22, which secure the springs to the upper collar. Inward collapsing of the springs will cause their upper and lower portions 18 to merely flatten against the exterior of the casing, with the outward expanding tendency of the terminal portions 21 of the springs being prevented and resisted by the continuous collar sections 20, the force exerted by the terminal portions not being imposed on the plug welds 22.

Inasmuch as the welds need not resist the outward movement of the terminal portions 21 of the spring 12, a very good and strong weld is not esesntial to the proper fabrication and operation of the apparatus. In view of the fact that the welds are not critical, a less expensive spring steel can be used for the outwardly bowed spring member 12, but despite the use of a more economical spring steel, the springs themselves will still possess the proper desirable spring characteristics. The springs need not be of the finest quality as long as they have good weldability characteristics to insure the appropriate attachment of the springs to the collar. Because of the construction described, the collars 10, 11 can be made of lighter gauge material and still be of strong and rugged construction. The outer and inner inturned flanges 15, 17 at opposite ends of the larger diameter portion 16 of the collar aid materially in stiffening each collar and contributing to its strength. The lack of necessity for providing welds capable of withstanding great forces makes it possible to use a less expensive steel for the collars, and, in addition, the steel from which the collars are made can be of lighter gauge.

In addition to the economy of manufacturing the centralizer for the reasons pointed out above, it is capable of passing through close clearance surface casing. The intermediate portions 13 of the outwardly bowed springs can be flattened substantially completely against the casing A, the inward movement of the end portions 18 of the springs being permitted by the slotted collar construction. The extension of the inner portions of the slots 19 through the inner flanges 17 permits the springs to collapse inwardly until they will lie upon the outer periphery of the inner portions 14 of the collar. Inasmuch as the external radius of the intermediate collar portion 16 is greater than the external radius of the inner collar portion 14 by an amount equal to the thickness of a spring 12, the flattening of the spring against the periphery of the inner collar portion 14 will result in a collapsed spring diameter that is no greater than the outside diameter of the intermediate collar portion 16 itself. Thus, the external diameter of the intermediate collar portion 16 will determine the minimum size hole or surface casing through which the centralizer C can be moved. Such minimum outside diameter is reduced to a substantial extent, since it need only be the outside diameter of the casing plus twice the thickness of the collar and spring, the collar as stated above, being made of relatively light gauge material.

Accordingly, it is evident that a casing centralizer with outwardly bowed springs has been provided, in which relatively inexpensive materials can be used, and in which the welds need not be capable of withstanding much of the forces to which the centralizer is subjected. In addition, the diameter of an encompassing enclosure through which the centralizer can be moved is substantially less than in prior devices of a similar nature.

For the purpose of facilitating assembly of the centralizer on the casing string, it is preferred to make the upper and lower casing collars 10, 11 in sections that are hinged to one another, which will allow the collar sections to be spread apart for transverse disposition around the casing string. As disclosed, each collar is made of two like halves 28, 28 having hinged knuckles 29 at their circumferential ends which are substantially diametrically opposite one another. The hinge knuckles on one collar section will interleave with the hinged knuckles on the other collar section, after which a suitable hinge pin 30 can be inserted through all of the hinge knuckles of each hinge portion to secure the sections together. In effect, each centralizer collar is made of two main parts 28, 28 that have the springs 12 welded thereto. The two parts are placed around the casing section A, the hinge knuckles 29 being interleaved, and the hinge pins 30 on diametrically opposite sides of each collar section inserted through all of the knuckles. The knuckles 29 do not extend along the whole length of the collar sections, terminating inwardly of the innermost ends 26 of each collar, in order that the insertion of the hinge pin therethrough will not cause it to extend inwardly beyond the inner ends 26 of the collars. In effect, the hinge knuckles are only formed on the intermediate collar section 16 of greater diameter than the inner collar section, which will insure that the knuckles 29 are disposed outwardly of the periphery of the casing and

will not interfere with the ability of each collar to slide relative to the well casing.

With the hinged arrangement disclosed, a stop ring **25** need not necessarily be placed on the casing section by a welding operation, or the like, or in some other manner. Instead, the upper and lower collars **10, 11** can be placed on opposite sides of a casing coupling **25**, which secures adjacent casing sections A, A^1 together. The casing coupling **25** then acts not only to perform the primary function of securing the casing sections together, but also as an annular stop member engageable with either the lower collar **11** or the upper collar **10**, to pull the centralizer in either a downward or an upward direction within the well bore, depending upon the direction of which the casing string is moved.

The form of invention disclosed in Figs. 5 and 6 is similar to the embodiment illustrated in Figs. 1 to 4, inclusive. However, the inner portion **14** of each collar **10***a*, **11***a* is eliminated and the inner portion of the collar terminates at an inner internal flange **17***a* that extends inwardly to substantially the same extent as the outer internal flange **15***a*. The intermediate or web portion **16***a* of each collar is unslotted immediately adjacent its inner internal flange **17***a*, the inner ends of the slots **19***a*, however, terminating fairly close to the inner flange, in order to permit the springs **12***a* to deflect inwardly to a maximum extent before a spring would engage the inner unslotted portion **20***a* of the web.

The upper and lower collars **10***a*, **11***a* are alike, being oppositely disposed with respect to one another, the upper and lower ends **21***a* of the outwardly bowed springs **12***a* extending through the respective slots **19***a* and engaging the outer internal flanges **15***a*. Such ends **21***a* lie flush against the inner surface of the web portions **16***a* of the collars, to which they are plug welded, or otherwise suitably secured. The terminal portions **21***a* of the springs may be curved to conform generally to the curvature of the casing A, or other conduit string, on which the centralizer is mounted. Actually, the centralizer may slide along the casing by virtue of the bearing of such terminal portions **21***a* thereon, although the sliding and guiding of the centralizer may also be effected by the inner portions of the inner and outer internal flanges **17***a*, **15***a*.

The centralizer disclosed in Figs. 5 and 6 may be of the hinge type, and may be mounted on the casing string A with the upper and lower collars **10***a*, **11***a* on opposite sides of the annular stop ring **25**, in the same manner as the other form of invention. When the casing is moving downwardly in the well bore, the stop ring **25** engages the inner flange **17***a* of the lower collar **11***a*, to pull the springs **12***a* down along the wall of the hole B and past any restrictions or obstructions encountered therein. On the other hand, upward movement of the casing will cause the stop ring **25** to engage the inner flange **17***a* of the upper collar **10***a* to exert a pulling action on the springs **12***a*, sliding them along the wall of the well bore and past any restrictions or obstructions encountered therein.

The inventor claims:

1. An apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having an inner generally cylindrical portion to fit on the well conduit and an outer circumferential channel-shaped portion comprising longitudinally spaced flanges separated by a web integral therewith which is substantially parallel to and spaced outwardly of said cylindrical portion, one of said flanges extending inwardly of one end of said web and being integral with said cylindrical portion and the other of said flanges extending inwardly of the other end of said web, said web having circumferentially spaced longitudinally elongated slots therein; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exteriors of said

cylindrical portions, the end portions of said spring members extending through said slots and engaging the inner walls of said webs longitudinally outwardly of said slots; and means for securing said end portions of said springs to said channel-shaped portions longitudinally outwardly of said slots.

2. In apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having an inner generally cylindrical portion of a diameter to slidably fit on the well conduit and an outer circumferential channel-shaped portion comprising longitudinally spaced inner and outer flanges separated by a web integral therewith which is substantially parallel to and spaced outwardly of said cylindrical portion, said inner flange extending inwardly of said web and being integral with the outer end of said cylindrical portion, and said outer flange extending inwardly of said web; the web of each supporting member having circumferentially spaced longitudinally elongated slots therein extending longitudinally outwardly from said inner flange and terminating short of said outer flange, the portion of said web between said slots and said outer flange being circumferentially continuous; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exteriors of said cylindrical portion, the end portions of said spring members extending through said slots and engaging the inner walls of said circumferentially continuous web portions; and means for securing said end portions to said web portions.

3. In apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having an inner generally cylindrical portion of a diameter to slidably fit on the well conduit and an outer circumferential channel-shaped portion comprising longitudinally spaced inner and outer flanges separated by a web integral therewith which is substantially parallel to and spaced outwardly of said cylindrical portion, said inner flange extending inwardly of said web and being integral with the outer end of said cylindrical portion, and said outer flange extending inwardly of said web and having an inside diameter substantially equal to the inside diameter of said cylindrical portion; said web having circumferentially spaced longitudinally elongated slots therein extending longitudinally outwardly from said inner flanges and terminating short of said outer flanges, said slots extending through said inner flanges, the portion of each web between said slots and said outer flange being circumferentially continuous; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exteriors of said cylindrical portions, the end portions of said spring members extending through said slots and engaging the inner walls of said circumferentially continuous web portions, the termini of said spring members being disposed adjacent said outer flanges; and means for securing said end portions to said web portions.

4. In apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having an inner generally cylindrical portion of a diameter to slidably fit on the well conduit and an outer circumferential channel-shaped portion comprising longitudinally spaced inner and outer flanges separated by a web integral therewith which is substantially parallel to and spaced outwardly of said cylindrical portion, said inner flange extending inwardly of said web and being integral with the outer end of said cylindrical portion, and said outer flange extending inwardly of said web and having an inside diameter substantially equal to the inside diameter of said cylindrical portion; said web having circumferentially spaced longitudinally elongated slots therein extending longitudinally outwardly from said inner flanges and terminating short of said outer flange, said slots extending through said inner flange, the portion of each web between said slots and said outer flange being

circumferentially continuous; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exterior of said cylindrical portions, the end portions of said spring members extending through said slots and adapted to bear upon the conduit string and engaging the inner walls of said circumferentially continuous web portions, the termini of said spring members being disposed adjacent said outer flanges; and means for securing said end portions to said web portions; the outside diameter of said webs being equal to the outside diameter of said cylindrical portions plus twice the thickness of a spring member.

5. In apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having a circumferential channel-shaped portion comprising longitudinally spaced inner and outer flanges separated by a web integral therewith, said flanges extending inwardly of said web, said web having circumferentially spaced longitudinally elongated slots therein extending from a point adjacent said inner flange and terminating short of said outer flange, the portion of said web between said slots and said outer flange being circumferentially continuous; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exterior of said inner flanges, said spring members having end portions extending through said slots and engaging the inner walls of said circumferentially continuous web portions, the terminals of said end portions being adjacent said outer flanges; and means for securing said end portions to said web portions.

6. In apparatus adapted to be mounted on a well conduit: longitudinally spaced supporting members, each supporting member having a circumferential channel-shaped portion comprising longitudinally spaced inner and outer terminal flanges separated by a web integral therewith, said flanges extending inwardly of said web, said web having circumferentially spaced longitudinally elongated slots therein extending from a point adjacent said inner flange and terminating short of said outer flange, the portion of said web between said slots and said outer flange being circumferentially continuous; circumferentially spaced outwardly bowed spring members disposed around said supporting members and overlying the exterior of said inner flanges, said spring members having end portions extending through said slots and engaging the inner wall of said circumferentially continuous web portions, the terminals of said end portions being adjacent said outer flanges; and means for securing said end portions to said web portions.

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