Sept. 25, 1962 R. O. PARK 3,055,432

WELL CONDUIT CENTERING DEVICES

Filed June 23, 1960 2 Sheets-Sheet 1

FIG. 1.

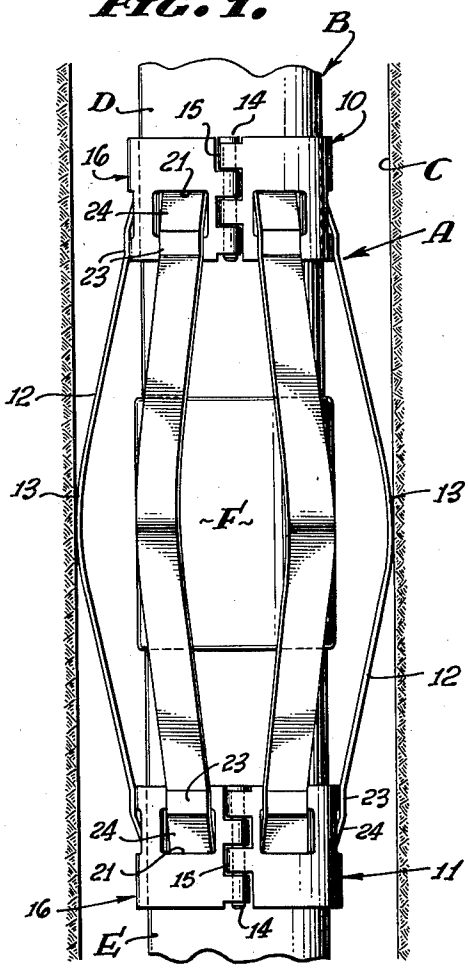


FIG. 2.

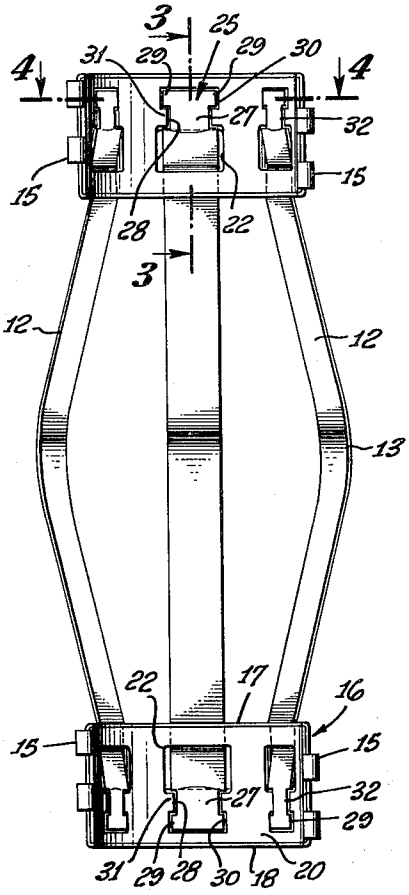


FIG. 3.

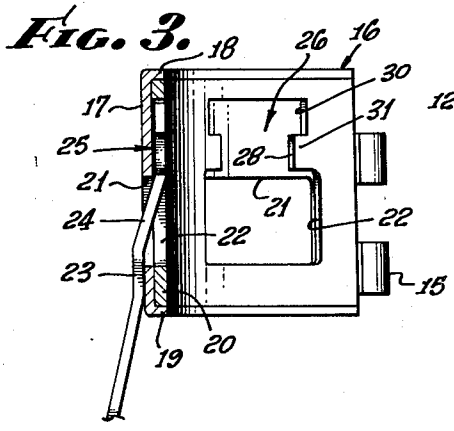
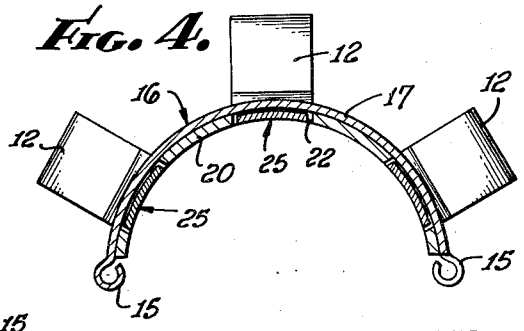


FIG. 4.



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FIG. 1.

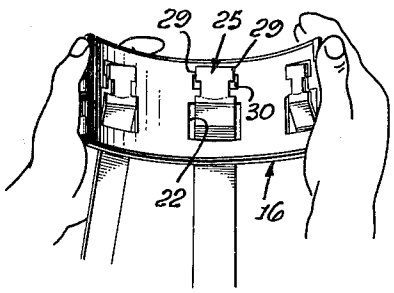


FIG. 5.

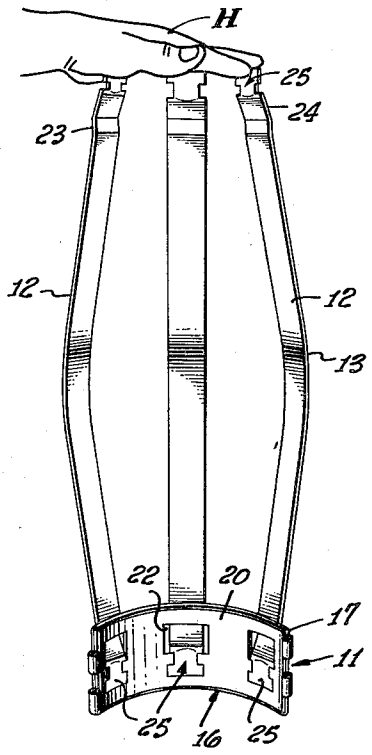


FIG. 8.

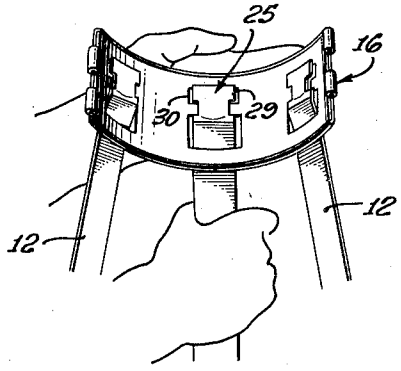


FIG. 6.

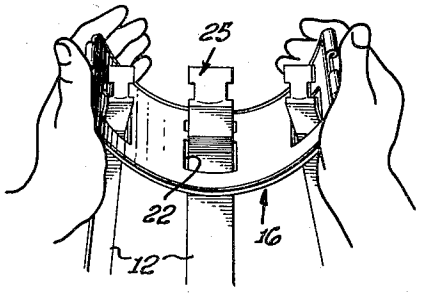
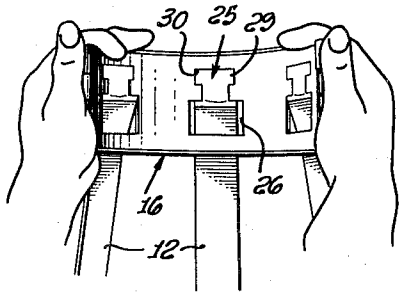


FIG. 9.



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3,055,432

WELL CONDUIT CENTERING DEVICES

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Filed June 23, 1960, Ser. No. 38,202
15 Claims. (Cl. 166—241)

The present invention relates to centering devices, and more particularly to devices adapted to be mounted on well casings, liners, tubings, and similar conduit strings, for the purpose of centering such strings in well bores.

Centering devices having outwardly bowed springs are mounted on casing strings, or similar conduit strings, disposed in well bores for the purpose of placing and maintaining the casing strings substantially coaxially in the well bores. Heretofore, the parts of such centering devices were permanently assembled to one another at the point of manufacture, requiring their shipment in the assembled condition. In view of the large space or volume occupied by an assembled centering device or centralizer, substantial labor and material costs are entailed in boxing or crating it for shipment. Moreover, shipping costs have been comparatively high because of the large bulk or volume presented by the complete centering device, whether shipped boxed or unboxed. The large volume of the centering device also requires correspondingly large storage or warehouse space, which is costly to provide.

Conduit string centering devices have included end collars or annular members to which outwardly bowed springs have been welded. The welding operation entails substantial investment in welding equipment, jigs and fixtures. Welding also limits the selection of materials for the bowed spring members, and also adversely affects the physical properties of the springs.

Accordingly, it is an object of the present invention to provide an improved centering device or centralizer for well conduits that can be shipped to the point of use in a disassembled and compact condition, and then readily assembled at such point of use, or at any other desired place, thereby effecting substantial savings in labor, material and time necessary for boxing, and in transportation costs, as well as in storage costs.

Another object of the invention is to provide a centering device or centralizer for well conduit strings that requires no fixtures or special equipment for its assembly. In fact, the parts of the centralizer can be assembled by one person and by hand, even without the aid of hand tools.

A further object of the invention is to provide a centering device or centralizer for a well conduit embodying outwardly bowed springs adapted to be attached to associated collars or annular members without welding the parts to one another, thereby avoiding heating of the spring members and adverse effects upon their physical properties.

Yet another object of the invention is to provide a centering device for a well conduit in which the centering spring members can be assembled to the collars by hand, and in which the springs remain properly assembled to the collars during normal handling of the device, during its installation on the well conduit, and during its running in the well bore. The springs remain assembled to the collars in the absence of mounting the centering device on the well conduit.

An additional object of the invention is to provide a centering device for a well conduit, the springs of the device being assembled readily by hand in self-locking relation to the collars of the device, whereby disassembly of the device cannot be accomplished inadvertently, or by hand alone, but only through the aid of proper tools and through the exertion of substantial effort.

Still a further object of the invention is to provide a centering device for a well conduit embodying springs attached to collars, in which inward force or load on the springs tends to retain the attachment and assembled relation of the springs to the collars.

Another object of the invention is to provide a centering device for a well conduit embodying springs capable of ready assembly by hand to associated collars, the assembled device being economical to produce, and being of strong and sturdy construction.

This invention possesses many other advantages and has other objects which may be made more clearly apparent from a consideration of a form embodying the invention. This form is shown and described in the present specification and in the drawings accompanying and constituting a part thereof. It 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 elevational view of a centering device mounted on a conduit string and disposed in a well bore;

FIG. 2 is a side elevational view of the inner portion of one-half of a centering device;

FIG. 3 is an enlarged section taken along the line 3—3 on FIG. 2;

FIG. 4 is an enlarged section taken along the line 4—4 on FIG. 2;

FIG. 5 illustrates the first step of assembling outwardly bowed springs in a lower collar section;

FIG. 6 is a view illustrating a step in placing an upper collar section on the upper portion of the springs;

FIGS. 7, 8 and 9 are views similar to FIG. 6 showing subsequent steps in performing and completing the assembly of an upper collar section to the upper portions of the outwardly bowed springs, to provide the half of a centering device illustrated in FIG. 2.

As illustrated in FIG. 1, a centering device A is mounted on a conduit string B, such as a string of well casing, that is run in a well bore C, and which is to be maintained in substantially a centered condition therewithin. The casing string includes an upper casing section D and a lower casing section E suitably secured to one another by a coupling collar F.

The centering device A includes upper and lower collar members 10, 11 slidably mounted on the casing string B, and intervening outwardly bowed springs 12 secured to the collars with their mid-portions 13 adapted to bear against the wall of the well bore C, to hold the casing string centered or substantially centered therewithin. The upper and lower collars 10, 11 are disposed on opposite sides of the coupling collar F, the latter functioning as a stop ring, being adapted to engage the lower collar 11 and pull the centering device downwardly in the well casing, the coupling member F also being adapted to engage the upper collar 10 in pulling the centering device upwardly in the well casing upon upward movement of the casing string B therewithin. As is known in the art, in lieu of mounting the centering device A on opposite sides of a coupling member F, the entire device could be mounted on a single section of casing B with a stop ring F suitably secured to said section between the upper and lower collars 10, 11 of the centering device.

The centering device A consists of two main half sections that can be placed laterally around the conduit string B and then secured to one another. One of such half sections is shown in FIG. 2, the other half section being a duplicate thereof. The parts of each half section can be assembled to one another by hand and without

the aid of any special tooling, and such half sections then secured to one another, to complete the centralizer, upon placing of the half sections around the conduit string and then inserting hinge pins 14 through the interleaved hinge knuckles 15 on diametrically opposite sides of each of the collars 10, 11.

The upper and lower collars or annular members 10, 11 are duplicates of one another, being oppositely arranged. Thus, the upper collar 10 includes two half sections or segments 16 attached to one another by the diametrically opposite hinge pins 14, the half sections being the same. As shown, each section includes an outer sleeve section 17 having upper and lower inwardly directed flanges 18, 19 integral therewith. Such a sleeve section may be formed readily from sheet metal. The ends of each outer sleeve section terminate in the hinge knuckles 15, the hinge knuckles at one end being in staggered relation to the hinge knuckles at the other end, such that when two outer sleeve sections 16, 16 are placed against one another, the hinge knuckles 15 on one sleeve section will interleave with the hinge knuckles on the other section, whereby the sections 16, 16 are in transverse alignment with one another, being held in assembled relation upon insertion of the hinge pins 14 through the interleaved hinge knuckles.

Secured to each outer sleeve section 17 is an inner sleeve section 20, which serves to reinforce the outer sleeve section, and also enables the terminals or ends of the outwardly bowed springs 12 to be locked to the collar section 10, in the manner hereinafter described. Preferably, the inner sleeve section 20 abuts, or substantially abuts, the upper and lower inwardly directed flanges 18, 19, the section 20 being suitably and firmly secured, as by spot welding, to the outer sleeve section 17. The inner sleeve section 20 preferably extends around substantially the full arcuate extent of the outer sleeve section 17, terminating at the hinge knuckles 15, 15.

The collar section 16 has circumferentially spaced openings 21, 22 through which the ends of the springs 12 can be inserted from the exterior of each collar section to its interior. Outer openings 21 are provided in the outer sleeve section 17 and substantially aligned inner openings 22 are provided in the inner section or sleeve member 20. Each of these openings 21, 22 is preferably substantially wider than the width of the portion of the spring 12 extending therethrough, to facilitate assembly of the springs to the collar section or segment 16, as described hereinbelow.

An upper portion 23 of each spring 12 may be substantially parallel to the axis of the collar 10, serving as a heel or fulcrum bearing against the exterior of the outer sleeve member 17 below its opening 21. This heel or fulcrum 23 merges into an inclined spring portion 24 extending inwardly through the openings 21, 22, such intersection portion merging into a terminal portion 25, which, when assembled to the collar section, is adapted to be substantially parallel to the axis of the collar. This terminal portion 25 is preferably curved, conforming to the curvature of the collar 10, and particularly to the curvature of the inner reinforcing sleeve 20, so as not to project substantially inwardly of such sleeve.

The terminal portions 25 of each spring are each formed as a generally T-shaped head adapted to be received in a correspondingly shaped slot 26 in the inner reinforcing sleeve 20 of the collar. As shown, the longitudinal portion 27 of the head fits within the corresponding longitudinal portion 28 of the T-shaped slot, the outer portion of the head having oppositely directed tongues 29 extending arcuately of the collar and being received in companion grooves 30 constituting the upper portion of the slot 26. The tongues 29 fit with proper working clearance within the companion grooves 30 and the inwardly directed finger portions 31 of the inner reinforcing sleeve member 20 extend under the tongues 29 and fit closely adjacent the longitudinally extending part 27 of the T-shaped head 25. In fact, the fingers 31 may be considered to fit within companion grooves 32 in the sides of the terminal portion 25 of the spring.

It is to be noted that when the springs 12 are assembled through the openings 21, 22 in the collars, and with their heads 25 received within the companion slots 26, such heads are prevented from moving outwardly since they will engage the outer sleeve section 17 of the collar, which overlies the slots. The heads 25 cannot move inwardly, as a result of inward force directed on an outwardly bowed spring 12, since the heel or fulcrum portion 23 of the spring bears against the exterior of the outer sleeve 17 below its opening 21, and tends to shift the head 25 in an outward direction against the inner surface of the outer sleeve 17. Upwardly directed forces on the upper collar 10 are transmitted from the fingers 31 directly to the tongues 29; whereas upwardly directed forces on the springs 12 are transmitted directly from the ends of the springs to the upper ends of the T-shaped slots 26. Once the springs 12 are assembled with their T-shaped terminal heads 25 within the companion shaped slots 26 on each collar section, in both the upper and lower collars 10, 11, one-half of the centralizer has been assembled, such as shown in FIG. 2. The springs 12 cannot be removed inadvertently from assembled relation to the collars 10, 11.

The lower portion of the centering device is the same as the upper portion, except the parts are oppositely directed. The springs 12 fit through the openings 21, 22 in the half section 16 of the lower collar 11, and the T-shaped heads 25 are disposed in the companion T-shaped slots 26 in the same manner as was described above in connection with the upper portion of the device.

Two completed half sections of the centering device are then placed laterally around the conduit string B, with the upper and lower collars 10, 11 on opposite sides of a stop ring F. Hinge pins 14 are then inserted through the interleaved hinge knuckles 15 at diametrically opposite points of each collar, to complete the assembly and to retain the half sections connected to one another. These hinge pins 14 may, if desired, make a force fit with the hinge knuckles 15, so as to remain secured thereto and to avoid inadvertent removal therefrom.

In the use of the centering or centralizer device A illustrated, it is mounted on the well casing B, as described, and the latter is then run in the well bore. During downward movement, the stop ring F engages the lower collar 11, the lower collar in turn contacting the lower tongues 29 and pulling the springs 12 downwardly through the well bore C, and past any obstructions or restrictions that might be encountered therewithin. As was described above, the terminal portions 25 of the springs cannot shift from their companion slots 26, since any inward force on the intermediate portions of the springs 12 results in a tendency for the terminal portion 25 to shift outwardly against the outer sleeve sections 17, due to the fulcruming of the heel portions 23 on the exterior of the collar. The terminal portions 25 cannot shift inwardly of the collar, in view of the bearing of the heel portion 23 on its exterior. Although not essential, upon mounting of the centering device on the conduit string B, the periphery of the latter makes a fairly close fit with each collar 10, 11, as well as with the terminal portions 25 of the springs, the latter being prevented by the conduit string itself from moving inwardly out of the slots.

Even prior to assembling the centering device on the well casing, the parts of the half sections, such as shown in FIG. 2, cannot be disassembled from one another, since such disassembly can only occur as a result of tilting each collar half section 16 relative to the terminals or ends 25 of the springs. Due to the curvature of each collar section, tilting cannot occur since the portions of the collar defining the slots 26 will engage the tongues 29 of the outer terminal members. As an example,

tilting of the upper portion of the upper collar section outwardly, and its lower portion inwardly, to remove the T-shaped heads 25 from the slots 26, will cause the inwardly directed fingers 31 to engage the outer tongues 29 of the spring members, as well as the upper ends of the slots 26 to engage the inner, other tongues of the spring members, such tilting thereby being precluded. The only manner of removing the tongues 29 from the slots is to place a heavy screwdriver, or the like, under the ends of the springs and forcibly pry the latter out of the slots, a very great force being required in accomplishing this act.

Despite the fact that the springs 12 cannot be readily disassembled from the collars 10, 11, the assembly of the springs to the collars can occur in a comparatively easy manner and without the use of any special tools or equipment or, for that matter, without the use of any kind of tools. The mode of assembly is shown in FIGS. 5 to 9, inclusive. In FIG. 5, the lower ends of the springs have been inserted through a lower collar section 16 and their T-shaped heads 25 appropriately placed in the companion T-shaped slots 26. This can occur easily since the upper ends of the springs are free and the springs can be moved readily to insure the assembly of the lower terminals of the springs in their companion slots. The hand H of a person performing the assembly operation then holds the upper portions of the outwardly bowed spring members 12, such as shown in FIG. 5.

An upper collar section 16 is then tilted and slipped over the upper ends of the springs 12, such as shown in FIG. 6. To enable such tilting action to occur, and to permit the upper portions of the springs to pass through the collar section openings 21, 22, the latter have a substantially greater width than the width of the spring. The upper collar section is then shifted to as near a vertical position as possible, such as shown in FIG. 7, in which the upper part of the collar section is shifted in a direction toward the observer and the lower part in an outward direction, or away from the observer, the inner tongues 29 of the outer springs 12 (not the middle spring) being in point contact with the lower sides of their companion grooves 30. At this time, the head 25 of the middle spring is engaging the inner surface of the reinforcing sleeve 20 above the T-shaped slot 26.

While holding the exterior of the collar section with one hand, the middle or center spring is pushed in an outward direction with the other hand, such as disclosed in FIG. 8, to increase the bow thereof and decrease its over-all length, until the T-shaped head 25 seats fully within the companion T-shaped slot 26 in the collar section. That is to say, the tongues 29 will be received substantially fully within the companion grooves 30. Such action will be accompanied by a further tilting of the collar section 16 towards the vertical or upright position, the T-shaped heads 25 of the other, outer springs moving more fully into their companion slots 26.

The collar section can then be grasped by the hands at its outer portion, such as shown in FIG. 9, and the collar easily tilted toward the vertical position, whereupon the terminal portions 25 of the outer springs will seat fully within their companion T-shaped slots 26. This will result in an assembled one-half of the centering device, such as illustrated in FIG. 2. As set forth above, the springs 12 will remain in such assembly relative to the upper and lower collar sections since the latter cannot tilt inadvertently relative to the terminals 25 of the springs due to the interference between the tongues 29 of the end springs and the sides of the companion T-slots 26 in the sections. The one-half of the centering device can be moved around, or handled normally, without fear of disassembly of the springs from the collar sections. When the full centralizer is to be completed, the two halves are placed laterally toward each other over the casing B, and on opposite sides of the stop ring F, and the hinge pins 14 inserted in place, as above described.

With the foregoing arrangement, the springs 12, collar sections 16 and hinge pins 14 can be shipped as separate parts, whereas a complete centralizer occupies a considerable volume, as is evident from FIG. 1. The springs 12 can be separately stacked in close relation to one another, which is also true of the collar sections 16 and also the hinge pins 14. Thus, a centralizer in a disassembled condition occupies only a small fraction of the volume of the centralizer in the assembled condition. Accordingly, boxing or crating costs are considerably less when shipment in the disassembled condition occurs, which is also true of shipping costs and warehousing costs. If desired, the parts need only be assembled when the centering device is to be mounted on the conduit string B, and this can take place at the well site, if desired. The springs 12 are readily mounted in the upper and lower collar sections 16 by hand, as in the manner described above, the two centering device sections placed on the conduit string B at the desired location and the lock pins 14 inserted in place. In addition, it is to be noted that there is no welded connection between the springs 12 and the collar members 10, 11 so that a proper material, such as a desired spring steel, can be selected for the outwardly bowed leaf springs, since its being affected by welding need not be considered.

The centering device is a strong and sturdy construction, capable of withstanding relatively great forces. It is to be noted that the inner sleeve 20 reinforces the outer sleeve 17. Thus, endwise forces imposed on the outer sleeve are not only transmitted through the latter but also from its lower flange 19 directly to the inner sleeve 20, the inner sleeve, in effect, substantially increasing the effective thickness of the outer sleeve 17 and making the entire collar device 10, 11 capable of transmitting large compressive loads safely.

The inventor claims:

1. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a supporting member having a plurality of circumferentially spaced openings therein and slots within said supporting member adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs overlying the exterior of said supporting member and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots, said portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that portion of said supporting member defining, in part, said slot extension to interlock said spring extension with said portion of said supporting member to prevent removal of said spring portion from said slot.

2. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a supporting member having inner and outer portions and a plurality of circumferentially spaced aligned openings in said portions and slots within said inner portion adjacent to and communicating with said openings; the outer portion of said supporting member extending across said slots; circumferentially spaced outwardly bowed springs overlying the exterior of said supporting member and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots and engageable with said outer portion of said supporting member, said spring portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that part of said supporting member defining, partially, said slot extension to interlock said spring extension with said part of said supporting member to prevent removal of said spring portion from said slot.

3. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a supporting member having a plurality of circumferentially spaced openings therein and generally T-shaped slots within said supporting member adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs overlying the exterior of said supporting member and extending inwardly through said openings; said springs having generally T-shaped portions disposed in said slots; said T-shaped portions of said springs including tongues extending arcuately around said supporting member and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

4. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a supporting member having inner and outer portions and a plurality of circumferentially spaced openings therein and generally T-shaped slots within said inner portion adjacent to and communicating with said openings; the outer portion of said supporting member extending across said slots; circumferentially spaced outwardly bowed springs overlying the exterior of said supporting member and extending inwardly through said openings; said springs having generally T-shaped portions disposed in said slots and engageable with said outer portion of said supporting member; said T-shaped portions of said springs including tongues extending arcuately around said supporting member and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

5. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars having a plurality of circumferentially spaced openings therein and slots within said collars adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs extending between and overlying the exteriors of said collars and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots, said portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that portion of said supporting member defining, in part, said slot extension to interlock said spring extension with said portion of said supporting member to prevent removal of said spring portion from said slot.

6. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars having a plurality of circumferentially spaced openings therein and generally T-shaped slots within said collars adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs extending between and overlying the exterior of said collars and extending inwardly through said openings; said springs having generally T-shaped portions within said collars and disposed in said slots; said T-shaped portions of said springs including tongues extending arcuately around said collars and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

7. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars each having inner and outer portions and having a plurality of circumferentially

spaced openings therein and generally T-shaped slots within said inner portions adjacent to said openings and communicating therewith; circumferentially spaced outwardly bowed springs extending between and overlying the exterior of said collars and extending inwardly through said openings; said springs having generally T-shaped portions within said collars and disposed in said slots; said T-shaped portions of said springs including tongues extending arcuately around said collars and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots; the outer portion of each of said collars extending across the slots of said collar; said T-shaped portions of said springs being engageable with said outer portions of said collars.

8. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a collar comprising two substantially half sections adapted to be secured together; each section having a plurality of circumferentially spaced openings therein and slots within said section adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs overlying the exterior of said section and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots, said portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that portion of said section defining, in part, said slot extension to interlock said spring extension with said portion of said section to prevent removal of said spring portion from said slot.

9. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a collar comprising two substantially half sections adapted to be secured together; each section having a plurality of circumferentially spaced openings therein and generally T-shaped slots within said section adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs overlying the exterior of said section and extending inwardly through said openings; said springs having generally T-shaped portions disposed in said slots; said T-shaped portions of said springs including tongues extending arcuately around said section and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

10. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars, each collar comprising two substantially half sections adapted to be secured together, each section having a plurality of circumferentially spaced openings therein and slots within said sections adjacent to and communicating with said openings; circumferentially spaced outwardly bowed springs extending between said collars and overlying the exterior of said sections and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots, said portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that portion of said section defining, in part, said slot extension to interlock said spring extension with said portion of said section to prevent removal of said spring portion from said slot.

11. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars, each collar comprising two substantially half sections adapted to be secured

together, each section having inner and outer portions and having a plurality of circumferentially spaced openings therein and slots within said inner portions adjacent to said openings and communicating therewith; circumferentially spaced outwardly bowed springs extending between said collars and overlying the exterior of said sections and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots and engageable with said outer portion of said section, said spring portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that part of said inner portion of said section defining, partially, said slot extension to interlock said spring extension with said part of said inner portion of said supporting member to prevent removal of said spring portion from said slot.

12. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a collar comprising two substantially half sections adapted to be secured together; each half section including an outer sleeve section and an inner sleeve section fixed to said outer sleeve section; said outer and inner sections having a plurality of aligned circumferentially spaced openings therethrough; said inner section having slots adjacent to and communicating with said openings and said outer section overlying and closing said slots; circumferentially spaced outwardly bowed springs overlying the exterior of said outer section and extending inwardly through said openings; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots and engageable with said outer sleeve section, said spring portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that part of said inner sleeve section defining, partially, said slot extension to interlock said spring extension with said part of said inner sleeve section to prevent removal of said spring portion from said slot.

13. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: a collar comprising two substantially half sections adapted to be secured together; each half section including an outer sleeve section and an inner sleeve section fixed to said outer sleeve section; said outer and inner sections having a plurality of aligned circumferentially spaced openings therethrough; said inner section having generally T-shaped slots adjacent to and communicating with said openings and said outer section overlying and closing said slots; circumferentially spaced outwardly bowed springs overlying the exterior of said outer section and extending inwardly through said openings; said springs having generally T-shaped portions disposed in said T-shaped slots; said T-shaped portions of said springs including tongues extending arcuately around said inner section and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

14. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars, each collar comprising two substantially half sections adapted to be secured together; each half section including an outer sleeve section and an inner sleeve section fixed to said outer sleeve section; said inner and outer sections having a plurality of aligned circumferentially spaced openings therethrough; said inner section having generally T-shaped slots adjacent to and communicating with said openings and said outer section overlying and closing said slots; circumferentially spaced outwardly bowed springs extending between said collars and overlying the exterior of said outer sections of said collars and extending through said openings; said springs having generally T-shaped portions disposed in said slots; said T-shaped portions of said springs including tongues extending arcuately around said inner sections and received within companion portions of said T-shaped slots, said tongues and companion portions of said slots being of substantially the same longitudinal extent to prevent substantial longitudinal movement of said T-shaped portions in said T-shaped slots.

15. In a centering device adapted to be mounted on a running-in string to be disposed in a well bore: upper and lower longitudinally spaced collars, each collar comprising two substantially half sections adapted to be secured together; each half section including an outer sleeve section and an inner sleeve section fixed to said outer sleeve section; said inner and outer sections having a plurality of aligned circumferentially spaced openings therethrough; said inner section having slots adjacent to and communicating with said openings and said outer section overlying and closing said slots; each of said slots having a circumferential extension spaced longitudinally from its adjacent opening; said springs having portions disposed in said slots and engageable with said outer sleeve section, said spring portions including extensions received in said slot extensions, whereby each of said spring extensions longitudinally overlaps that part of said inner sleeve section defining, partially, said slot extension to interlock said spring extension with said part of said inner sleeve section to prevent removal of said spring portion from said slot.

References Cited in the file of this patent

UNITED STATES PATENTS

1,336,673	Bernton	Apr. 13, 1920
2,248,160	Crawford	July 8, 1941
2,738,019	Atkinson	Mar. 13, 1956
2,845,128	Clark et al.	July 29, 1958