United States Patent

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[54] **PROGRESSIVE CENTRALIZER**
10 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **166/241**
[51] **Int. Cl.** **E21b 17/10**
[50] **Field of Search** 166/241, 202, 173

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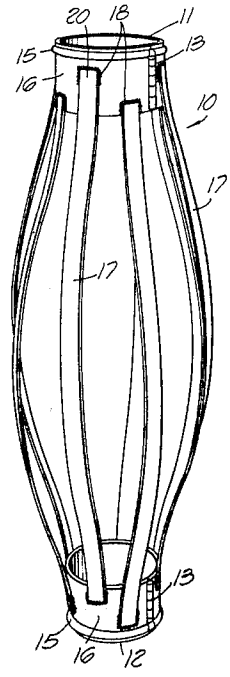
ABSTRACT: A well pipe centralizer with a plurality of outwardly bowed springs extending between aligned collars adapted to fit the well pipe wherein the position of some of the spring bows on the collars is longitudinally offset from other spring bows whereby less than all of the spring bows are engaged simultaneously when forcing the centralizer into a restricted opening.



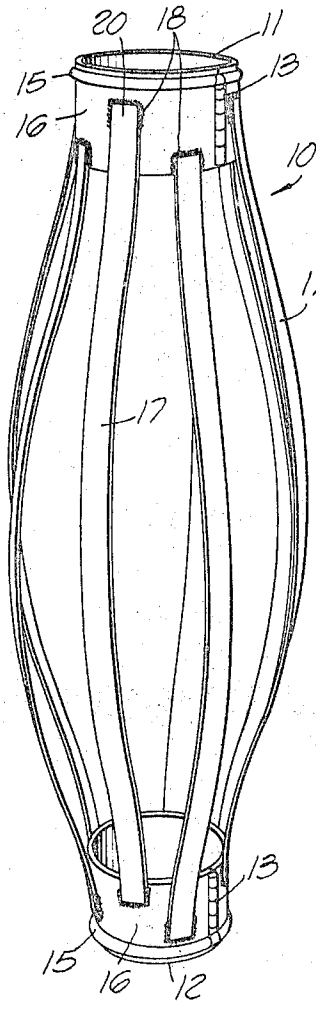


FIG. 1.

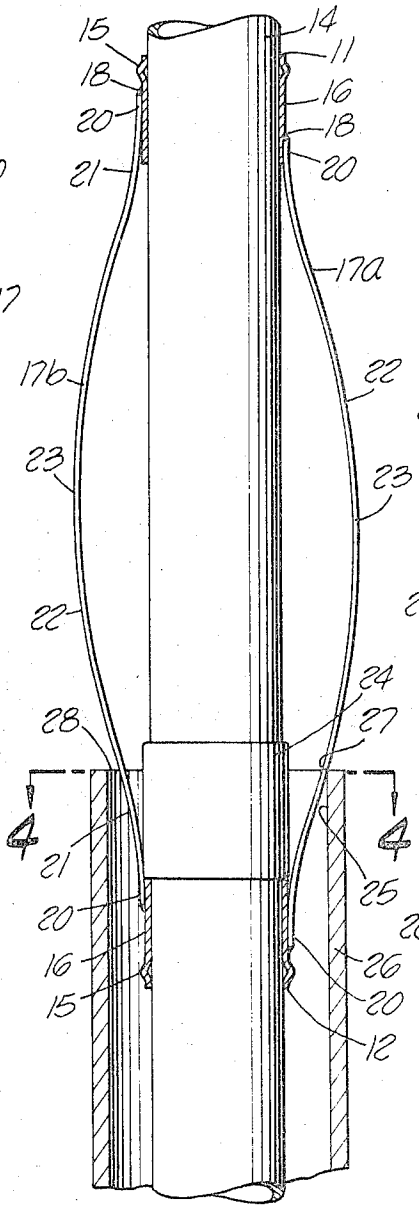


FIG. 2.

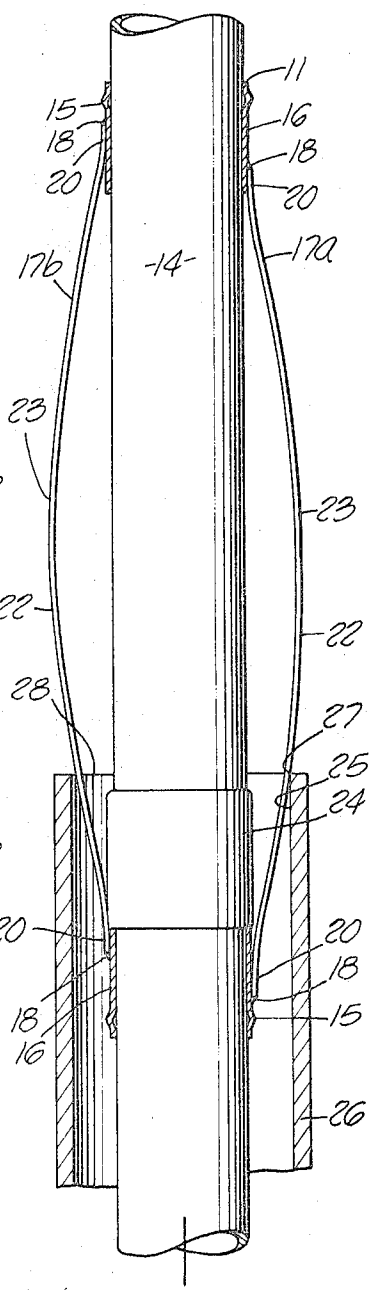


FIG. 3.

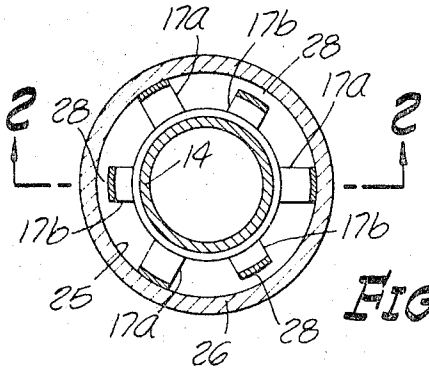


FIG. 4.

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PROGRESSIVE CENTRALIZER

This invention relates to centralizers for well pipe and in particular is directed to a centralizer construction for reducing the force required to insert the centralizer in a restricted opening without changing the centering force produced by that centralizer.

A variety of different types of devices have been used for many years in oil, gas and water wells for centering or partially centering a well pipe within either the well bore or another larger well pipe. The most common device of this type is comprised of a pair of spaced collars with a plurality of outwardly bowed springs extending between the collars and is called a "centralizer." Normally all of the bowed springs on a given centralizer are of the same although the bow profile, length and material width and thickness will vary from centralizer to centralizer. The bow profile, length, and material as well as the number of bows per centralizer are selected for each centralizer to produce a given centering force and other characteristics, and as a result different centralizer models produce different centralizing forces and other characteristics due to the differences in bows.

Under certain circumstances such as well bores inclined at a substantial angle to the vertical and only a small clearance between the well pipe and the well bore, the centering force required of the centralizer is of such a high magnitude that substantial difficulty is encountered in even starting the centralizer into the casing at the surface of the well. A similar problem is encountered when the well bore is underreamed to a larger diameter than the well casing leading thereto and yet it is desirable to center the well pipe in the underreamed well bore. In other words the centering force requirement dictates the use of heavy material in the bows, a large number of bows, and a profile with the spring bowed outwardly a substantial distance and yet the centralizer and well pipe on which it is mounted must be inserted in a casing that is only slightly larger, perhaps less than 1 inch clearance per side, than the well pipe. Since the centralizer bows are normally longitudinally aligned they all engage the casing into which they are being inserted simultaneously and thereby produce a substantial resistance to insertion due to both the force required to collapse the bows and the frictional force between the bows and the surrounding casing.

In summary it is a principal object of this invention to provide a novel form of centralizer wherein some of the spring bows are longitudinally offset from others whereby less than all of the spring bows are simultaneously engaged by the casing into which the centralizer is inserted for reducing the force required to effect such insertion.

Another object of this invention is to provide a well pipe centralizer having a preselected number, size and shape of identical spring bows for producing the desired centering force wherein some of the spring bows are longitudinally offset a significant distance relative to the remaining spring bows whereby only certain spring bows will engage any restrictive opening into which the centralizer is inserted prior to such engagement by the remaining spring bows thereby reducing the force required for such insertion. A still further object of this invention is to provide such a centralizer wherein approximately one-half of the spring bows are longitudinally offset from the other one-half whereby such insertion force is approximately the same in both directions.

Other and more detailed objects and advantages will appear from the following description and the accompanying drawings wherein:

FIG. 1 is a perspective view of a hinged centralizer embodying this invention.

FIG 2 is a sectional elevation taken substantially on the line 2–2 in FIG. 4 and illustrating the centralizer of this invention mounted on a well pipe and being inserted into another well pipe at a position near the start of such insertion.

FIG. 3 is a sectional elevation substantially similar to FIG. 2 but illustrating the centralizer of this invention in a position inserted a further distance into the well pipe than shown in FIG. 2.

FIG. 4 is a sectional plan view taken substantially on the line 4–4 in FIG. 2.

Referring now in greater detail to the drawings, the centralizer of this invention is generally designated 10 and in many respects is of somewhat conventional construction. It will readily appear to those skilled in the art that the centralizer 10 may vary substantially in proportions, numbers of bows, shape of collars and bows, etc. in a variety of manners that are somewhat conventional in the industry but without departing from this invention when incorporating the herein described features.

The centralizer 10 includes a pair of collars 11 and 12 hereinafter for convenience referred to as upper and lower collars, respectively, although it will readily appear that the device may be inverted thereby changing such orientation. In the form of the device shown in FIG. 1 the collars 11 and 12 are each provided with a pair of diametrically located hinges 13 whereby the collars are comprised of two half-collars hinged together for ease in mounting the centralizer on a well pipe. The collars 11 and 12 have an internal diameter adapted to fit the well pipe 14 and are axially aligned in the assembled form for mounting on the well pipe 14. The collars may be provided with reinforcing beads 15 extending circumferentially as is relatively conventional. The collars have a substantial amount of axial or longitudinal length which is substantially cylindrical and forms a mounting surface 16 on the exterior of the collars.

A plurality of spring bows 17 extend longitudinally between the collars 11 and 12 and are mounted thereon by any convenient means such as welding 18. The number of bows 17 used in each centralizer is predetermined on the basis of such factors as the size of the well pipe 14, the required centering force, etc. which number may vary from centralizer to centralizer. It is to be noted that for illustration purposes the centralizer 10 of FIG. 1 is shown with eight bows (some partially obscured) while the centralizer of FIGS. 2, 3 and 4 is shown with six bows for convenience. Conventionally and in the centralizer of this invention, each of the bows 17 is of substantially the same profile, length and material thickness and width within manufacturing tolerances although this may be varied as desired without departing from this invention. The spring bows 17 are of a somewhat typical shape or profile that is symmetrical from end to end and comprises relatively straight end mounting portions 20 joined to outwardly curving portions 21 which are in turn connected either directly or through straight portions to an inwardly curved central portion 22 having a large radius of curvature thereby completing the bow profile. Since the bow 17 is symmetrical from end to end the midpoint 23 of the bow is the farthest point from the well pipe 14 and determines the effective overall diameter of the centralizer.

While normally the spring bows of a centralizer are mounted with their ends all longitudinally aligned, as for example immediately adjacent the collar bead 15 on both collars, in the device of this invention the end mounting portions 20 of some of the bows are longitudinally offset from other bows. As shown in FIG. 2 the right-hand bow 17*a* has its lower end mounting portion 20 welded to the mounting surface 16 with the extremity immediately adjacent the collar bead 15 whereas the upper end mounting portion 20 is positioned a substantial distance from the mounting bead 15 of upper collar 11. Conversely the left-hand spring bow 17*b* in FIG. 2 has its lower end mounting portion 20 substantially spaced from the bead 15 of lower collar 12 while its upper end mounting portion 20 is immediately adjacent the bead 15 on collar 11. In this manner the bows 17*a* and 17*b* are longitudinally offset with bow 17*a* below bow 17*b* and as a result each point along bow 17*a* is below a corresponding point of the identical bow 17*a*. For convenience it is preferred that one-half of the bows 17 be offset in one direction and the other one-half offset in the opposite direction whereby the centralizer is the same whether inverted or upright. Thus in the embodiment shown in FIGS. 2, 3 and 4 where the centralizer has six bows 17, there are three bows 17*a*

positioned lower than three bows 17*b*. Moreover for further symmetry it is preferred that the staggered bows be alternated around the circumference of the device, that is, with a low-positioned bow 17*a* between high-positioned bows 17*b* and vice versa. Thus with the six bow centralizer 10 shown in FIGS. 2, 3 and 4 a low-positioned bow 17*a* is diametrically located relative to a high-positioned bow 17*b* although even in the preferred arrangement this would not occur with centralizers having four, eight or 12 bows since identical high or low positioned bows would be diametrically located.

The centralizer device 10 is used in the conventional manner by installing the device on the well pipe 14 as the pipe is run into the well. With a hinged style centralizer as shown in the drawings it may be installed over the coupling or collar 24 of the well pipe 14, that is, with the well pipe collar 24 positioned between the upper and lower collars 11 and 12 of the centralizer to thereby limit the travel of the centralizer along the well pipe. Another conventional manner in which the device may be installed is with a stop collar or lugs positioned between collars 11 and 12 and affixed to the well pipe 14 at any point along its length. With nonhinged centralizers, both conventional and the type of this invention, the centralizer is slipped onto the well pipe and the stop device is affixed between the upper and lower collars.

With the centralizer 10 so mounted, the well pipe 14 is lowered into the well and as shown in the drawings this will include forcing the centralizer into a restricted opening 25 formed by the inner surface of the well casing 26 which normally will extend to the surface of the well. In the particular adverse condition that is overcome by this invention, the restricted opening 25 will be substantially smaller than the effective outside diameter of the centralizer at the bow midpoints 23 thereby requiring substantial collapsing of the bows to accomplish insertion of the centralizer into the casing 26. Without limitation but by way of a typical example, the well pipe 14 may have an outside diameter of 6⅝ inches, the effective diameter of the centralizer at midpoints 23 may be approximately 17 inches and the well casing 26 may be 8⅝ inch size having an inside diameter of less than 8 inches whereby the bows 17 each must collapse approximately 4½ inches or a total of 9 inches in diameter. Moreover since there is very little annular space between the well pipes 14 and 26 the top edge 27 of well pipe 26 will first engage the spring bow 17 on the outwardly curved portion 21 where the outer surface of the bow is at a substantial acute angle to the longitudinal direction of movement and produces a sharp engagement with the upper edge 27. However since bows 17*a* are positioned below bows 17*b*, the portions 21 of only the lower bows 17*a* will be the first to engage the edge 27. Thus the initial forces resisting insertion of the centralizer 11 are produced only by one-half the bows i.e. bows 17*a* since a gap 28 remains between the bows 17*b* and the upper edge 27 of the well casing 26. As the bows 17*a* are collapsed by the downward movement of the well pipe 14 the straightening of bows 17*a* will force the upper collar 11 upwardly which in turn will tend to collapse the remaining bows 17*b* by pulling both ends of bows 17*b* although there is no engagement between bows 17*b* and the casing 26. Upon further downward movement of the well pipe 14 as shown in FIG. 3 the lower-positioned bows 17*a* will continue to collapse, still pushing the upper collar 11 upwards and in turn collapsing bows 17*b*, and while the gap 28 may narrow substantially or even disappear whereby contact will be made between bows 17*b* and the well casing 26, the frictional resistance between bows 17*b* and the upper edge 27 will be zero or only nominal. Of course upon further progression all of the bows 17 will eventually be collapsed to the diameter of internal surface 25 whereby the midpoints 23 of all the bows will engage such surface to produce the centering force and consequently produce a sliding friction between the centralizer and surface 25.

By this arrangement of this invention with the centralizer spring bows staggered it has been found that the downward force on the well pipe 14 which is required to insert the centralizer into the restricted opening formed by the casing 26 is reduced substantially to a magnitude of even less than one-half the force normally required when the same bows are mounted in a nonstaggered relationship. This is achieved without reducing the centering forces produced by the centralizer 10 in that the same bows are employed.

I claim:

1. A well pipe centering device comprising, a collar adapted to be mounted on the well pipe, a plurality of circumferentially spaced spring bows each having a first end mounted on said collar with all of said bows extending longitudinally of the well pipe in the same direction from said collar, each said spring bow having a second end and being bowed outwardly between said ends to a profile for resiliently centering the well pipe, first and second ends of each said spring bow mounted for free relative longitudinal movement upon collapsing of the spring bow, and at least some of said plurality of spring bows having their outwardly bowed profiles longitudinally offset with respect to the remaining spring bows for reducing the force required for inserting the device into a restricted tubular opening.

2. The device of claim 1 wherein said plurality of spring bows each have substantially the same bowed profile and said longitudinal offset relationship is produced by longitudinally offsetting the said first ends of said some bows with respect to the first ends of said remaining bows.

3. The device of claim 1 wherein one-half of said spring bows are longitudinally aligned, and the other one-half of the spring bows are longitudinally aligned with each other and longitudinally offset from the first said one-half.

4. The device of claim 3 wherein each said spring bow is longitudinally offset from each of the circumferentially adjacent spring bows.

5. A centralizer for a well pipe to be inserted in a restricted tubular opening comprising, a pair of axially aligned and spaced collars adapted to fit the well pipe, a plurality of circumferentially spaced spring bows extending longitudinally between and having ends mounted on said collars, said plurality of spring bows each being bowed outwardly to a profile for resiliently centering the well pipe in a well and all said bows having substantially the same profile, and the bow ends of at least some of said plurality of bows being longitudinally offset in their position of mounting on said collars with respect to the position of mounting of the remaining spring bow ends for causing certain of said spring bows to be engaged and urged to collapse before others upon inserting the centralizer into the restricted tubular opening for reducing the force required for so inserting the centralizer.

6. The centralizer of claim 5 wherein one-half of said spring bows are longitudinally aligned, and the other one-half of the spring bows are longitudinally aligned with each other and longitudinally offset from the first said one-half.

7. The centralizer of claim 6 wherein each said spring bow is longitudinally offset from each of the circumferentially adjacent spring bows.

8. An improved centralizer having a pair of collars adapted to fit a well pipe and a plurality of outwardly bowed and circumferentially spaced spring bows extending longitudinally between and mounted on said collars, the improvement comprising, at least some of said plurality of bows having their outwardly bowed profiles longitudinally offset with respect to the outwardly bowed profiles of the remaining spring bows for causing certain of said spring bows to be engaged and urged to collapse before others upon inserting the centralizer into a restricted tubular opening for reducing the force required for so inserting the centralizer.

9. The improved centralizer of claim 8 wherein said plurality of spring bows each have substantially the same profile and have end portions mounted on said collars, said end portions of some bows being longitudinally offset from said end portions of the remaining bows for producing said offset relationship.

10. The improved centralizer of claim 8 wherein each said spring bow is longitudinally offset from each of the circumferentially adjacent spring bows.