United States Patent

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[54] **CENTERING DEVICE**
9 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **166/241,** 308/4
[51] **Int. Cl.** **E21b 17/10**
[50] **Field of Search** 166/241, 202, 172, 173, 138, 213; 308/4A; 15/104, 19

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ABSTRACT: A centering device is provided for centering a well casing in a well or a drill string within a casing which comprises two spaced collars connected by outwardly bowed strips which act as springs to centralize the casing or drill string. Additionally, means are provided to restrict the movement of the collars apart so that the resilient strips always maintain an outwardly bowed shape and hence keep the member being centered spring resistent and restrict the movement of the collars apart so that the casing or drill string does not bear against the walls of the space in which it is desirably centered.

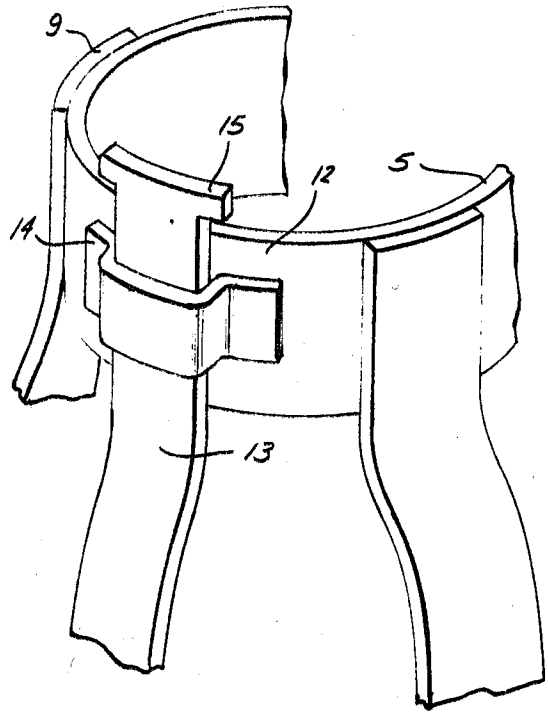

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Fig. 1

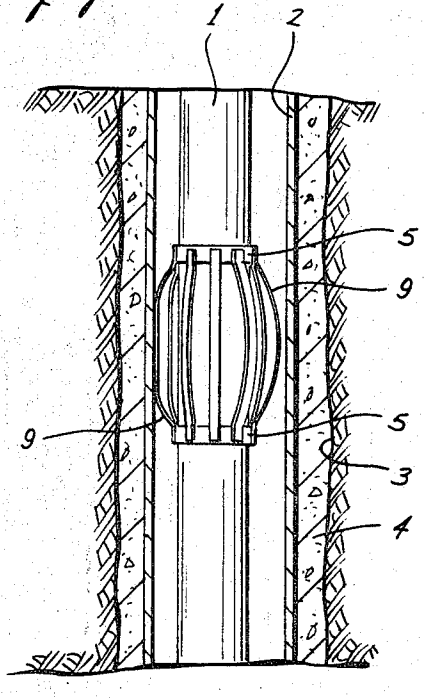


Fig. 2

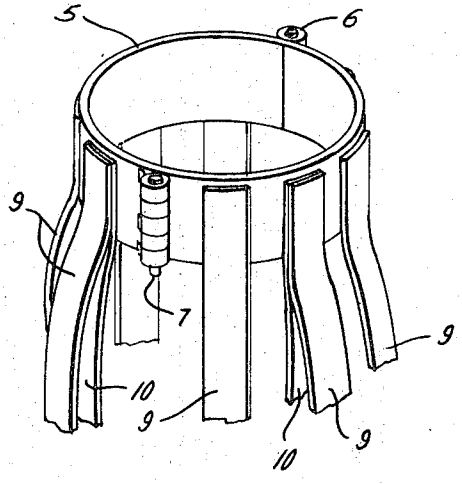


Fig. 3

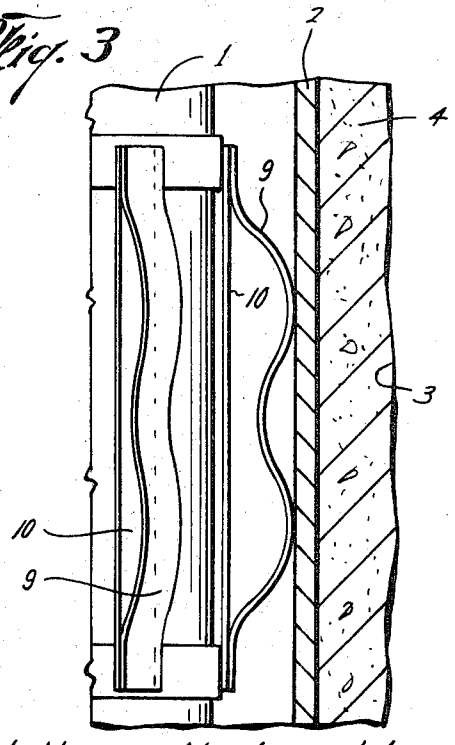
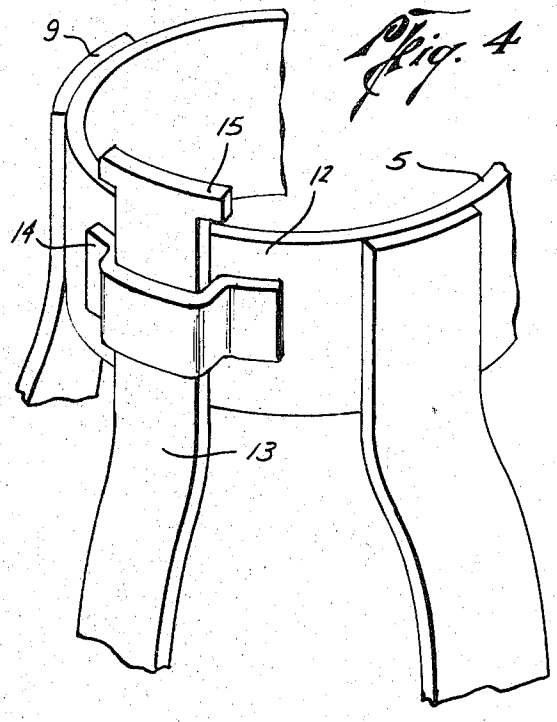


Fig. 4



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CENTERING DEVICE

CENTERING DEVICE

The instant invention relates to a novel tool useful for centering a first member longitudinally within a second member. More specifically, the instant invention provides a novel device useful in centering a casing in a well borehole or within a larger casing fixed in the borehole.

In the well-drilling arts, it is often necessary and desirable to center a casing or pipe within a second casing or pipe or within the borehole. Particularly in directional drilling operations and the like where the borehole is not vertical, and is not intended so to be, such centering must be accomplished to prevent an inner casing from resting on the wall of an outer casing by virtue of the nonvertical nature of the hole.

Accordingly to achieve the centering desired, centering devices have been mounted on the inner casing to maintain it at least some distance from the outer casing wall. Such devices have heretofore involved two spaced-apart collars to be fixed on the inner casing with outwardly bowed strips, resilient in nature, which would serve as springs and maintain the inner casing spaced from the outer casing wall. However, in directional drilling or instances where there is a bend in the borehole, the cumulative weight of the inner casing at the regions downhole is sufficient to overcome the spring effect of the resilient strips. In such cases, the resilient strips are completely compressed and the inner casing will rest against the wall of the outer casing or of the borehole and fail to maintain its central position.

In the alternative, centralizing of one well casing within another has also been effected by using such centralizing devices as described above having blocks mounted on the inner side of the resilient strips such that after limited compression of the resilient strips, the blocks will come to rest against the wall of the inner casing and hence will maintain it in a more central position. Centralization of well casing has also been similarly accomplished by mounting centralizing skids or blocks to the wall of the inner casing such as by welding or the like. Such methods relying upon rigid blocks for centralization purposes are disadvantageous in several respects. Initially, it is undesirable to weld or otherwise fix blocks directly to casing wall because of expense and the limitation such fixtures may present in future use of the casing. Moreover, the rigidity of the blocks tends to cause sticking of the casing downhole when the block is pulled against a burr in an outer casing or an irregularity in the borehole.

In accordance with this invention, there is provided a simple and inexpensive device which may be mounted on well casings or the like and which serve to center the casings within another casing or a borehole.

Although reference herein is primarily the use of the centering device of this invention for centering an inner well casing in a borehole or within an outer well casing, it will be understood that the novel device of this invention may be employed in other applications wherein it is desired to center one member longitudinally within another. Also, although the novel devices of this invention are illustrated and described with references to their use with round well casings, it shall be understood that the devices of this invention can be adapted to members of nonround cross section, e.g., square, rectangular, triangular, or the like to center such members longitudinally within a hole or casing or the like.

It is a first object of this invention to provide a novel device which may be used to center one member longitudinally within another.

It is among the further objects of this invention to provide such a centering device which may be removably mounted on the member to be centered.

It is among the further objects of this invention to provide such a novel centering device wherein the clearance between the inner centered member and the outer member is maintained by use of resilient means.

It is a further object of this invention to provide such a centering device wherein the resiliency of the means maintaining the clearance between the inner centered member and the outer member is preserved under virtually all conditions of stress.

In accordance with this invention, there is accordingly provided a centering device comprising two spaced collars adapted to be mounted longitudinally on the member to be centered, a set of resilient elements connecting the spaced collars about the periphery of said collars, said resilient elements having a bow in the direction outwardly from the member being centered, and a means to restrict movement of the collars apart, such that the distance between said collars is maintained less than the length of said resilient elements between said collars. It is to be understood that the outward bows need not define the arc of a circle and may have any suitable, outwardly extending shape as will be hereinafter pointed out.

The instant invention will be more particularly understood with reference to the accompanying drawings.

FIG. 1 is a pictorial cutaway view of a borehole showing an inner well casing centered within an outer well casing by means of the novel device of this invention.

FIG. 2 is a pictorial perspective view showing a centering device in accordance with one aspect of this invention.

FIG. 3 is a half-section side view of a centering device in accordance with FIG. 1 illustrating the behavior of the outer strips under conditions of severe stress.

FIG. 4 is a pictorial view of a portion of a centering device illustrating a further embodiment of this invention.

Referring specifically to FIG. 1, there is shown the novel centering device of this invention in place on a casing string in a borehole. Inner casing 1 is run through outer casing 2 which in turn has been previously affixed within borehole 3 with cement 4. The inner casing 1 is shown tending to bear against the left sidewall of outer casing 2. A like situation could, of course, occur if the inner casing 1 was run directly down the borehole. A centering device in accordance with this invention is in place on inner casing 1, and serves to center the inner casing with respect to the outer casing. As will be readily noted from the drawings and from this disclosure, the device of this invention does not function to maintain the inner casing in the precise center of the outer casing or the borehole, but it does serve to maintain a clearance between the inner casing and the wall of the outer casing or borehole around the entire periphery of the inner casing, and hence centralize the inner casing.

Spaced collars 5 of the centering device of this invention are mounted on inner casing 1. A series of centering devices may be placed at intervals along inner casing 1. Each of the spaced collars 5 are hinged at 6 to permit the centering device to be more easily mounted on casing pipe. The hinges are longitudinally aligned on the upper and lower collars. On the opposite side of each collar from the hinge, there is disposed a latching device to lock the device into the casing once mounted. One arrangement illustrated involves a pin 7 passed through holes in each portion of the collar which become axially aligned when the hinged collar is closed around the casing.

The ends of outer resilient strips 9 are fastened to the spaced collars 5 and serve to hold them in spaced relation with each other. Outer resilient strips 9 have an outwardly bowed shape such that as the inner casing 1 tends to bear against the outer casing 2, the outer surface of the outer strips 9 is first to contact the outer casing. These outer strips 9 are referred to as resilient in that they will flex and bend as the inner casing tends to bear against the outer casing thus cushioning any shock which might result from sudden movement of the inner casing 1 and tending to preclude the the possiblity of damage which might occur to the outer casing if a rigid block or skid were mounted on the inner casing.

Referring specifically to FIG. 2, there is shown in detail the particular embodiment of the novel centering device of this invention illustrated in FIG. 1. In this embodiment, a second set

of inner resilient strips **10** having an outward bow are affixed to the spaced collars **5** inside outer strips **9**. The length of the inner strips **10** is shorter than the length of outer strips and hence the inner strips do not bow outwardly to the extent that do the outer strips. If the arc configuration of the strips **9** and **10** correspond essentially to or at least approximate the circumference of a circle, as in the illustrated embodiment, it may be stated that the arc of the inner strips **9** correspond to the arc of a circle of greater radius than the arc of outer strip **10**.

Although outer strips **9** and inner strips **10** are referred to as resilient, in the application of the instant novel device as a well-centering tool these strips are customarily fabricated of ⅛- to ¼-inch steel, and thus are not to be considered pliably springy members. In other applications, the resilience of the outer strips may not be required to be so great, and accordingly, different materials may be used to obtain various degrees of spring resistance in the outer and inner resilient strips.

Thus, an inner casing **1** bears against outer casing **2** as shown in FIG. **1**, the outer strips **9** are depressed thus tending to force the collars **5** apart. Although only outer strips **9** are under depression, the spring effect of inner strips **10** tending to hold collars **5** together serves to supplement the spring resistance offered by the outer strips. However, if pressure forcing inner casing **1** against the outer casing **2** is increased sufficiently, spaced collars **5** will be moved apart by a distance equal to the arc length of inner strips **10**. When the collars become so spaced, inner strips **10** are essentially straight and are virtually in pure tension resisting any further movement apart by the collars **5**. At this point, outer strips **9** increase in their rigidity and resistance to further depression since the restriction on the outward movement of collars **5** by the inner strips **10** prevents the outer strips from further expansion.

Despite the increased rigidity at this stage, however, outer springs **9** still retain a resilient nature. For example, if after the collars are fully spaced apart, the force pushing inner casing **1** and outer casing **2** together increases by virtue of a sudden movement or the like, outer strips **9** are not entirely rigid but may depress further forming a double arc as shown in FIG. **3**. If the increased force is released, the outer strips will then restore themselves to the single arc configuration. Thus, even in the state of severe depression, outer strips **9** continue to offer a measure of resiliency despite restriction on the outward movement of the collars.

It is also pointed out that the primarily inner strips, and the outer strips as well must be substantially nonextensible under the conditions of stress under which the device will be expected to perform. It is obvious that if the inner strips are extensible, their purpose in constraining outward motion of the collars would be obviated.

The use of inner and outer resilient strips in the construction of the novel centering devices of this invention enables the adaptability of the novel devices of this invention to produce the precise effects in centering one member within another. For example, outer strips **9** may be constructed of a lighter more flexible and more resilient material than inner strips **10**. Thus, the shock-absorbing ability of the outer strips will be increased while the stiffer spring resistance of the inner strips will tend to hold the collars together. Also there need not be provided an equal number of inner strips and outer strips, but for example, one inner strip may be affixed under alternate outer strips. In addition, adjustment of the comparative lengths of the inner and outer strips can also serve to produce varied effects depending on the original clearance between the member to be centered and the walls of space in which it is to be centered, and the ultimate clearance desired regardless of what may be called lateral forces tending to push the member off center. Illustratively, the inner strips can have length varying from 60 to 95 percent of the length of the outer strips.

Of course, the resilient elements need not be striplike, and rods or the like may be used. In some applications, strong springs having an outward bow could be employed.

Another embodiment of the novel centering device of this invention is shown in FIG. **4** wherein a slightly different method is employed to restrict the motion of the collars apart. In FIG. **4**, outer strips **9** are affixed to the spaced collars the upper of which is illustrated at **12** in the same manner as in the embodiment above discussed to function in the same manner during use. However, inner strips **13** operate somewhat differently. For example, inner strips **13** are permanently affixed to the lower collar (not shown) as are outer strips **9**, the inner strips **13**, being interspaced between the outer strips around the periphery of the collars. However, the opposite ends of the inner strips **13** are not affixed to the upper collar **12** but rather pass through sleeves **14** around the periphery of the collar. The ends of the inner strips **13** on the upper sides of the sleeves are supplied with stops **15** such that the strips may not be pulled back through the sleeves. It is pointed out that the length of inner strips **13** from the bottom collar to the stop must be shorter than the corresponding length of the outer strips **9** from lower collar **11** to upper collar **12**.

Upon being placed on a member to be centered, such as on a casing in a well, inner strips offer no spring resistance supplemental to the spring resistance of outer strips **9** until stop **15** is slided against sleeve **14** as a result of movement apart by the collars **11** and **12**. At this point, the supplemental spring action of inner strips due to the outward bow thereof will commence to take effect and tend to hold the collars **11** and **12** together. Thus, there is achieved a centering device which in use has a resistance to lateral forces which increases as the forces increase. Of course, as the collars **11** and **12** move further apart, the bow in inner strips **13** is eliminated until the strips assume an essentially linear configuration preventing further movement apart by the collars.

If desired, the embodiment of the invention illustrated in FIG. **4** can utilize straight rather than bowed inner strips which are affixed to the lower collar and pass through sleeves of collar **12**. In a further alternative, the inner strips **13** in the embodiment shown in FIG. **4** need not be affixed to either collar, with sleeves mounted on each collar and each end of the strips having stops to prevent sliding through the sleeves. Indeed a cable or wire could be used. In all cases, stops must be provided on the unsecured end or ends of the strip or cable at such distance as to prevent the movement of the collars **11** and **12** apart by a distance greater than the arc length of outer strips **9**. Of course, straight inner strips or cables do not provide any supplemental spring resistance, and such inner strips will merely serve to restrict the movement of the collars apart. Hence if a wire or cable is used, it may be affixed to both collars.

The novel device of this invention, in accordance with the various embodiments disclosed and illustrated may be employed to center a length of well casing, usually at least more than one joint or length of pipe, in another casing or within the borehole itself.

Thus, there is provided in accordance with the instant invention, in combination, a well casing centered within a borehole space, the space being defined by the borehole walls or by an outer casing, said casing consisting of more than one joint of pipe, and having at least one centering device in accordance with this invention as described herein, the centering device having a maximum clearance diameter generally smaller than the borehole space.

Although it is most generally the case that the borehole space is slightly larger than the maximum clearance diameter of centering device, in instances where one casing is to be centered within another, it may be desirable to center the casing more positively by using a centering device slightly larger in diameter than the outer casing. However, the downhole portions of a borehole are irregular when compared with a casing surface and can have portions where the hole opening is severely constricted. Thus, it should be kept in mind when using the novel device herein directly in a borehole. The device should have a maximum clearance diameter less than the minimum diameter of the borehole since irregularities and hole constrictions can result in the well casing being held up or

possibly becoming stuck at such irregularity or constriction. Of course, when centering one casing within another the diameter of the outer casing is known and thus such problems of constriction will not arise.

As pointed out above, although the instant invention is illustrated in embodiments adapted to be fitted to round pipe and the like, it will be understood that this invention shall be adaptable to any shape member in all the embodiments shown and disclosed by providing suitably shaped collars.

It should be noted that the inner strips in the embodiment illustrated in FIG. 4 are interspaced around the periphery of the collars between the outer strips rather than lying directly under the outer strips as in the FIG. 2 embodiment. Either method of relative positioning of the inner and outer strips may, of course, be employed in the various embodiments of the novel devices of this invention.

It shall be understood by those skilled in the art that the novel devices of this invention can be modified in its structure without departing from the spirit or scope of this invention. For example, the bow in the outer strips of the novel device may have a flattened portion where the strips will contact the outer casing or borehole wall, and indeed the outward configuration of such outer strips need not approximate a circular arc at all but may be adapted to have any outwardly extending shape which will suitably contact the outer casing or borehole wall. In a further example, if desired, the device may be equipped with springs or the like extending between the collars so as to increase the spring resistance as the collars move apart.

I claim:

1. A centering device comprising:

a. a first spaced collar adapted to be mounted on the member to be centered;

b. a second spaced collar having sleeves about the periphery thereof adapted to be mounted on the member to be centered;

c. a set of outer resilient elements affixed to and connecting said first collar and said second collar, said outer resilient elements having a bow in the direction outwardly from the member to be centered; and

d. a set of inner elements affixed to said first collar about the periphery thereof and passing through said sleeves on said second collar, the unsecured ends of said inner elements being equipped with stops such that the ends of said inner elements cannot pass through said sleeves, the length of said inner elements from said first collar to said stop being less than the length of said outer elements, such that the maximum distance between said first spaced collar and said second spaced collar is maintained less than the length of said outer elements.

2. The centering device of claim 1 wherein said inner elements and said outer elements are resilient strips having a bow in the direction outwardly from the member to be centered.

3. The centering device of claim 2 having longitudinally aligned hinges in each of the two spaced collars to permit the ready mounting of the device on a well casing.

4. A centering device comprising:

a. two collars for mounting on the member to be centered;

b. resilient elements affixed and connecting said collars, said resilient elements having a bow outwardly from the member to be centered; and

c. restricting elements affixed to one of said collars and slidably engaging the second of said collars, said restricting elements being shorter than said resilient elements and having means to restrict the movement apart of said collars to a distance less than the length of said resilient elements.

5. The centering device of claim 4 wherein said restricting elements provide supplemental spring resistance to the movement apart of said collars.

6. The centering device of claim 4 wherein said resilient elements and said restricting elements are resilient strips having a bow outwardly from the member to be centered.

7. The centering device of claim 4 having hinges in each of the collars to permit the ready mounting of the device in a well casing.

8. The device of claim 7 wherein said first resilient strips are sufficiently longer than said second resilient strips to assume a double arc configuration under conditions of severe depression.

9. The centering device of claim 8 wherein said collars have latch means to permit ready mounting of said device on said tubular member.