United States Patent

[11] 3,566,965

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Torrance, Calif.
Continuation of application Ser. No. 576,055, Aug. 30, 1966, now abandoned.

[54] **VARIABLE SIZE, MULTI-HINGE CENTRALIZER**
15 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **166/241,** 166/315
[51] **Int. Cl.** **E21b 17/10**
[50] **Field of Search** ..... 166/170, 172—6, 241, 315; 308/4 (A)

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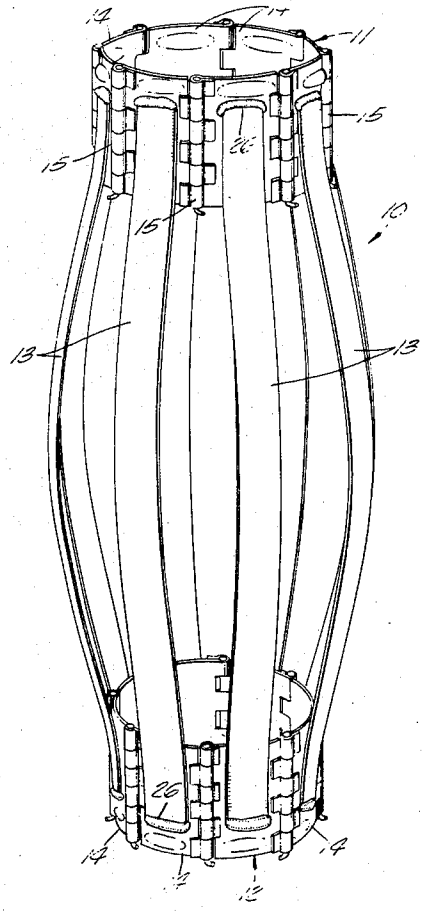
ABSTRACT: A device for centering well pipes in a well bore or casing with spring bows extending between spaced collars which are adapted for mounting on the well pipe wherein each collar is assembled from a multiplicity of releaseable hinge-connected segments to create a circumference which will closely encircle the well pipe with the number of segments being variable for accommodating different sizes of well pipe and the arcuate shape of each segment not necessarily conforming to the well pipe. Each spring bow extends between and is mounted on one segment of each collar.



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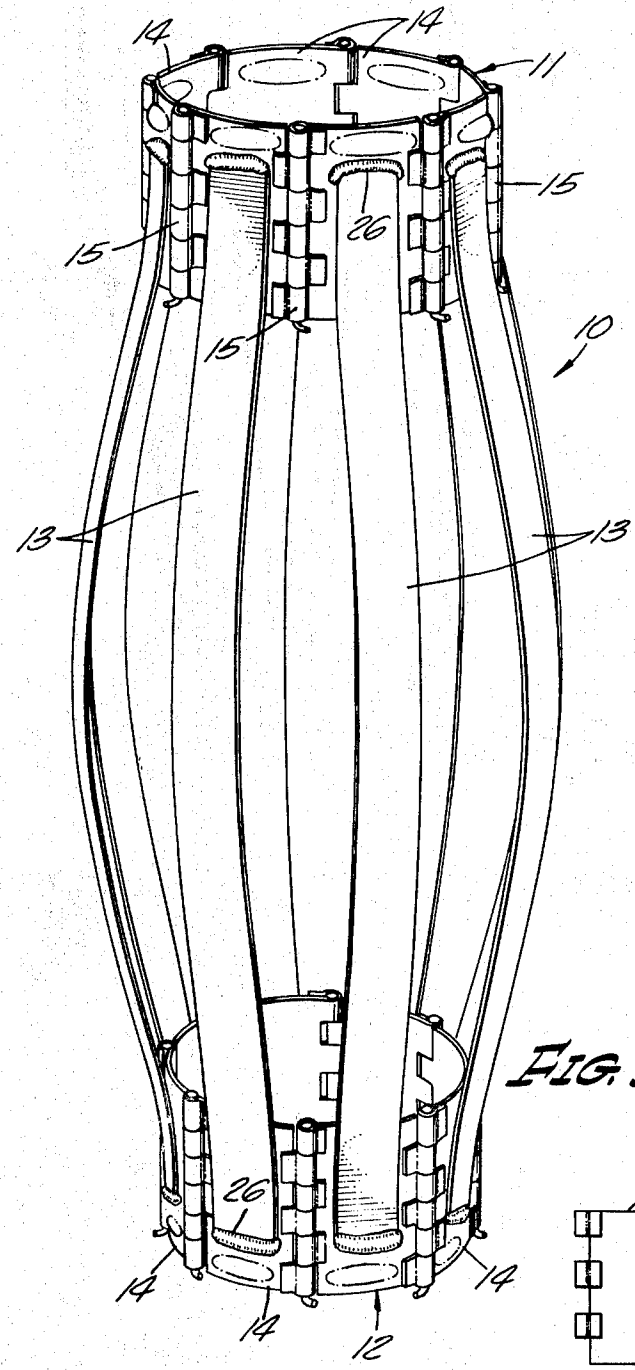

FIG. 1.

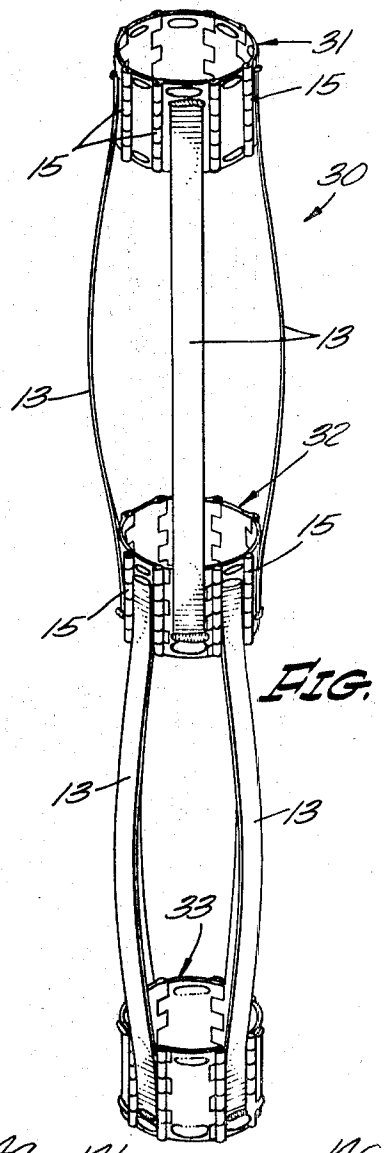

FIG. 2.

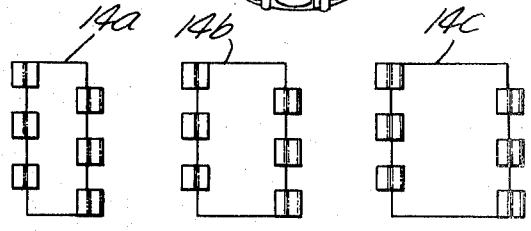

FIG. 4.

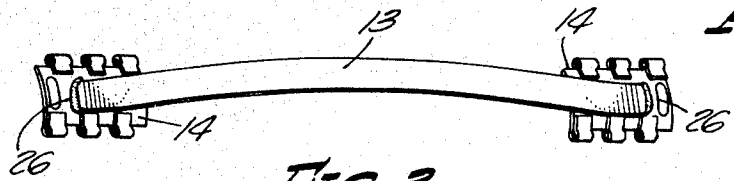

FIG. 3.

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FIG. 5.

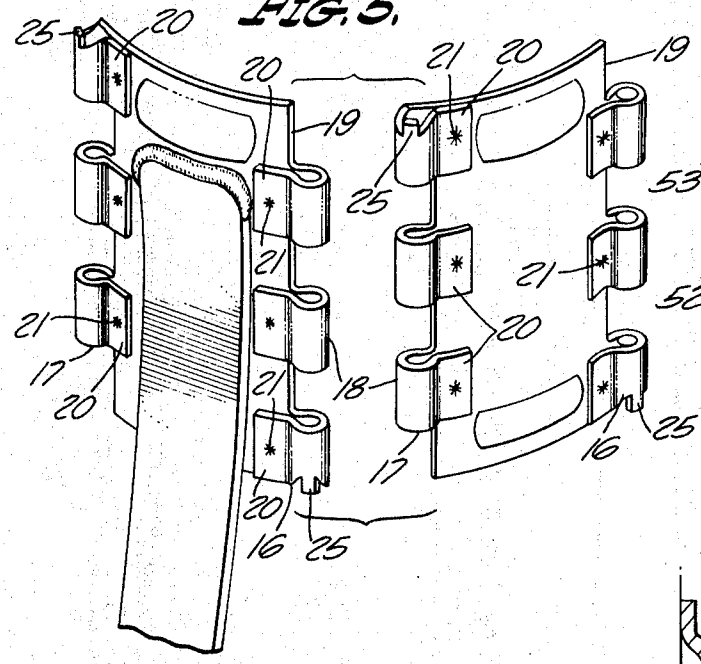


FIG. 8.

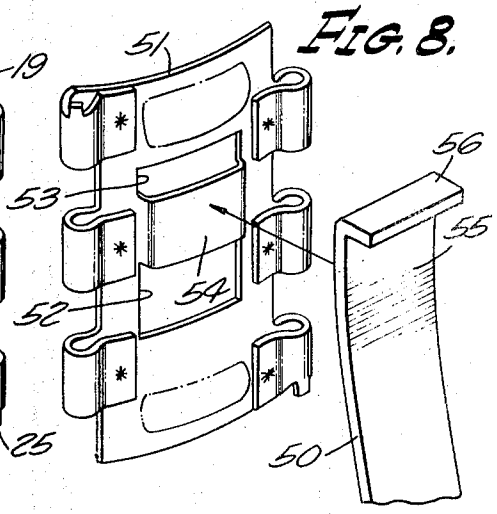
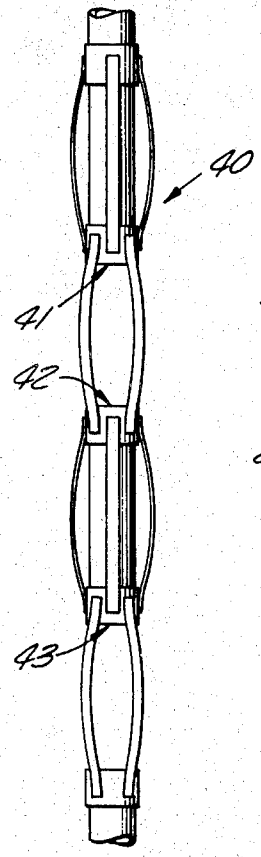
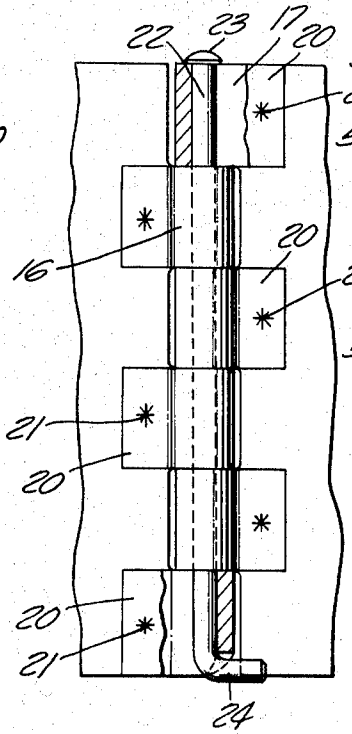


FIG. 6.





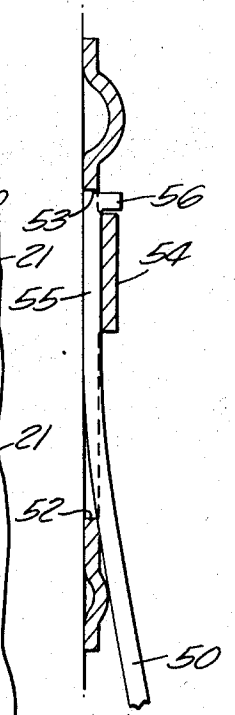


FIG. 9.

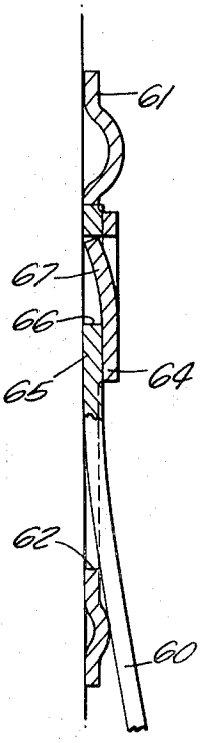


FIG. 10.

FIG. 11.

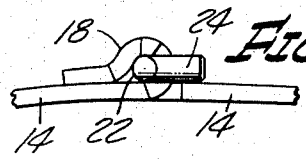


FIG. 7.

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VARIABLE SIZE, MULTI-HINGE CENTRALIZER

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of my copending application Ser. No. 576,055, filed Aug. 30, 1966, **entitled "Variable Size, Multi-Hinge Centralizer" now abandoned.**

This invention relates to centralizers for use on well pipe in centering the pipe in a well bore and, in particular, is directed to a centralizer device comprised of a multiplicity of hinged segments joined to form pipe fitting collars of any desired size by the addition or subtraction of segments.

Devices known as centralizers have long been in use in the oil industry for centering well pipe in or spacing well pipe from the wall of the well bore particularly when cementing the well pipe in the well bore. The most common conventional centralizers are comprised of two spaced collars adapted to fit the exterior of the well pipe with outwardly bowed staves extending between the collars to engage the well bore thereby resiliently centering the well pipe. Since there are approximately 25 different standard sizes of well pipe used in the oil industry, it has been necessary to provide a different centralizer for each well pipe size thereby presenting substantial problems in maintaining adequate inventories of all sizes at various locations for immediate availability. Moreover the size, shape and number of spring bows used on a centralizer for a given well pipe size may ideally differ depending on the well bore size, the degrees of slant in the well bore, and other conditions to be encountered. For example if the well bore is substantially larger than the well pipe, the spring bows must bow outwardly further to establish centering engagement than if the well bore were smaller. As a result it is not uncommon for a manufacturer to offer three of four different shapes of spring bows in his line of centralizers to accommodate the particular requirements thereby further compounding the problem of maintaining an adequate stock of all 25 sizes of each of the three or four styles of centralizers.

Another practical problem with conventional centralizers is the cost of shipping due to their bulky cagelike shape. Moreover if the wrong size conventional centralizer is shipped or the programmed well pipe size is changed in the interim, there is no convenient or practical way in which the size of a given conventional centralizer can be modified to fit a different size well pipe.

Accordingly it is a principal object of this invention to provide a novel form of centralizer wherein the collars are comprised of a multiplicity of releasably connected segments with each spring bow mounted on a segment of each collar whereby the size of the collars may be varied by adding or subtracting segments and any number or type of bows may be assembled with the segments to form the desired centralizer.

Another object of this invention is to provide a novel form of centralizer construction wherein the collars are comprised of a multiplicity of arcuate segments hinged together and the desired collar size is obtained by selecting an appropriate number of arcuate segments from one or more of just a few sizes of segments. Still another object of this invention is to provide such a centralizer with spring bows adapted to be readily mounted on such arcuate segments whereby the desired bow profile and number of bows may be mounted on a given centralizer. A still further object of this invention is to provide such a centralizer wherein the spring bows are releasably mounted on such arcuate segments.

A further object of this invention is to provide a novel form of centralizer construction wherein any number of tiers of bows may be mounted along the well pipe with a common collar between each tier of bows by means of the collars being comprised of a multitude of segments hinged together with the bows attached to individual segments, and on the common collar the bows of alternate segments extend in opposite directions from the collar.

It is a further object of this invention to provide a multiplicity of each of a few different components from which a wide variety of sizes and styles of centralizers can be readily and simply constructed without the need for special tools or equipment.

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

FIG. **1** is a perspective view of an assembled centralizer of this invention.

FIG. **2** is a perspective view of a modified embodiment of the centralizer of this invention comprised of similar components as the centralizer of FIG. **1** but assembled in a double-tier arrangement.

FIG. **3** is a perspective view of one of the basic components used in assembling centralizers of this invention comprising the spring bow and collar segments.

FIG. **4** is a composite view of three sizes of arcuate collar segments usable in constructing the various sizes of centralizers.

FIG. **5** is a fragmentary perspective view of two arcuate collar segments adapted to be hinged together for the centralizer.

FIG. **6** is a fragmentary elevation view of the hinge section of the segments joined by a hinge pin.

FIG. **7** is a fragmentary end view of the hinge section.

FIG. **8** is an exploded perspective view of a modified form of collar segment and spring bow adapted to be releasably assembled together for constructing a centralizer of this invention.

FIG. **9** is a sectional elevation view of the modified embodiment of FIG. **8** in the assembled condition of the bow and segment.

FIG. **10** is a further modified embodiment of the arcuate segment and spring bow adapted to be releasably assembled together similar to the embodiment of FIG. **8** and **9**.

FIG. **11** is an elevation view of a multi-tiered centralizer constructed in accordance with this invention and mounted on a well pipe.

Referring more particularly to FIG. **1**, a typical centralizer, generally designated **10** is illustrated as constructed in accordance with this invention. The centralizer **10** is comprised of a pair of collars **11** and **12** connected by a plurality of longitudinally extending spring bows **13**. The collars **11** and **12** are axially spaced and aligned for slidably fitting the exterior of the particular well pipe that is to be centered in the well bore. Normally a stop element will be provided on the well pipe to locate the centralizer therealong. The spring bows or staves **13** are of a selected profile to produce the desired overall diameter at their midpoints and the necessary strength to accomplish the well pipe centering in the particular well bore under the expected conditions. If the size of the well bore were a great deal larger than the size of the well pipe than it is likely and conventional that a bow profile which bows outwardly substantially more than that which is depicted for bows **13** would be selected. As thus far described the structure and functions of centralizer **10** are conventional and well known to those skilled in the art.

By this invention means are provided for forming the collars **11** and **12** of the centralizer **10** of any desired diameter to fit the particular well pipe and, as shown in the drawings, these means include a multiplicity of individual arcuate segments **14** releasably joined into the collar shape. Each of the segments **14** are curved in the circumferential direction to more closely fit the well pipe but it is to be noted that the radius of curvature of the segments need not be identical to the radius of the well pipe for the assembled collar to adequately fit the well pipe. If the radius of curvature of segments **14** is greater than the radius of the well pipe, it is obvious that theoretically only the center portion of each segment **14** will contact the well pipe whereas if the radius of curvature is less than the well pipe radius than the two edges of the segment will contact the well pipe. However in either case the segments **14** are of such a short circumferential width that no portion of a segment is spaced any great distance from the well pipe surface. In this regard for example it has been found adequate to employ a 3½inch radius of curvature for the arcuate segments **14** and

although this would only perfectly fit a 7-inch diameter well pipe the fit of the segments is completely adequate for all well pipe sizes which normally range from 2⅜-inch diameter to 20-inch diameter In part this is practical since the segments **14** are relatively short in the circumferential direction.

The arcuate segments **14** are releasably joined together by any convenient means such as hinge sections **15** along each longitudinal edge of the segment. Referring for detailed clarity to FIGS. **5**, **6** and **7** which show the same hinge sections illustrated in FIG. **1**, each hinge section **15** is comprised of a half section **16** on one segment **14** and another half section **17** on the next adjacent arcuate segment **14**. This results in each segments **14** having a half section **16** along one edge and a half section **17** along the other edge for mating with the hinge sections of adjacent segments on either side. Each hinge section **16** and **17** is comprised of three tubular elements **18** aligned and spaced along the longitudinal edge **19** of the arcuate segment. The tubular elements **18** may be of any convenient form and construction such as being integrally formed from the material of segments **14** by appropriately bending and forming tabs **20** back upon the segment and welding at **21**.

Although it is not essential to this invention it is preferred that three tubular elements **18** be provided with each half hinge section **16** and **17** thereby forming a hinge **15** of six aligned tubular elements joined by a hinge pin **22**. This provides the optimum balance between the stresses on the tubular elements **18** and the hinge pin **22**. The tubular elements **18** of half hinge section **16** obviously are offset from the tubular elements **18** of half hinge section **17** whereby they intermesh to receive the hinge pin **22**. The lowermost tubular element **18** on half hinge section **16** is adjacent the lower edge of the segment **14** while the uppermost tubular element **18** of the hinge half section **17** is adjacent the upper edge of the segment **14** whereby the hinge half sections are actually reversible. That is, the segment **14** in the right hand portion of FIG. **5** could be rotated 180° in the plane of the drawing and the half hinge section identified as **16** thereon would properly mesh with the half hinge section **16** of the left hand segment **14** for connection by a hinge pin **22**. This further enhances the versatility of this centralizer construction but is not absolutely essential. It will readily appear to those skilled in the art that although a particular hinge configuration is shown described any number of configurations of releasable connections could be readily employed without departing from this invention.

The arcuate segments **14** are held together in the assembled condition by hinge pins **22** which may have a head **23** and be bent over on the other end **24** to prevent inadvertent disassembly. Of course the last hinge pin **22** of each collar may be installed after the centralizer has been wrapped around the well pipe thereby avoiding the necessity of slipping the centralizer over the end of the well pipe. As an alternative to providing hinge pins **22** with a head **23** and of a length to bend over the end **24**, the uppermost and lowermost tubular elements **18** of the hinge section may be provided with tabs **25** that are capable of being crimped inwardly to cover the end of the tubular element after a straight, unheaded hinge pin has been inserted. When crimped the tabs **25** capture the hinge pin in the tubular elements.

In order to assemble a centralizer **10** having collars **11** and **12** of a size for fitting the particular well pipe it is necessary to employ a multiplicity of arcuate segments **14** and by selecting the appropriate number of arcuate segments from two or three different widths of segments the desired collar size can be achieved. The typical well pipe sizes for which collars must be constructed as measured by their outside diameters are 2⅜ inches, 2⅞ inches, 3½inches, 4 inches, 4½inches, 4¾ inches, 5 inches, 5½ 5¾ inches, 6 inches, 6⅝ inches, 7 inches, 7⅝ inches, 8⅝ inches, 9 inches, 9⅝ inches, 10¾ inches, 11¾ inches, 12¾ inches, 13⅜ inches, 14 inches, 16 inches, 18 inches, 18⅝ inches and 20 inches, although certain of these sizes are relatively uncommon. It has been found that collars to fit most of these well pipe sizes can be constructed from merely two widths of segments **14** but that a third width of segment **14** is advisable for constructing some sizes. Thus from the three different width segments **14***a*, **14***b* and **14***c* shown in FIG. **4**, collars may be constructed for each well pipe size by selecting the appropriate number of each segment width. Without limiting this invention a typical width for the intermediate size segment **14***b* may be 3 inches between the center lines of the tubular elements **18** which leaves adequate space between the tabs **20** to receive a normal width spring bow **13**. A smaller segment **14***a* would be used merely as a size adjusting link whereas most of the sizes would be accomplished by an appropriate number of segments **14***b* or **14***c* or a combination of both. thus for example four arcuate segments **14***b* linked together will adequately fit a 2⅞ well pipe while four segments **14***c* linked together may properly fit a 3½well pipe and so forth.

A modular element or unit of the composite centralizer **10** is comprised of a stave or spring bow **13** welded on each end at **26** to arcuate segments **14** as shown in FIG. **3**. This form would be factory assembled and painted for shipping in stacked relationship which obviously would be more compact than the assembled relationship shown in FIG. **1**. Field assembly merely requires selecting the appropriate number of modular units which have the desired bow profile and widths of arcuate segments **14** and assembling with hinge pins **22**. The entire centralizer **10** may be comprised of modular units whereby a bow **13** is attached to each of the arcuate segments **14** forming the collars as shown in FIG. **1** or "blank" segments **14** (without attached bows) may be interspersed between the modular units to provide a centralizer with fewer spring bows **13** where desirable This permits a careful selection and tailoring of the type and strength of centralizer installed at each location along a well pipe at the time of field installation which heretofore was impossible.

Referring more particularly to FIG. **2** a modified form of centralizer, generally designated **30**, is constructed from the same components heretofore described for constructing the more conventional style centralizer of FIG. **1**. Centralizer **30** is double tiered and in that respect is similar to a few heretofore conventional though uncommon centralizers. Centralizer **30** includes an upper collar **31**, middle collar **32** and a lower collar **33** in axially spaced and aligned relationship. In the centralizer **30** shown each of the collars **31**, **32** and **33** are comprised of eight individual arcuate segments **14** hinged together in the aforedescribed manner. The upper collar **31** and lower collar **33** are comprised of alternate segments **14** which are blank between segments which have spring bows **13** connected thereto. The middle collar **32** has bows **13** connected to each arcuate segment **14** with alternate bows extending in opposite directions. Since the hinge sections **16** and **17** of each hinge **15** are reversible as heretofore described it will readily appear to those skilled in the art that the modular units comprising the upper half of double-tiered centralizer **30** are the same as those comprising the lower half thereby further illustrating the versatility of this construction arrangement. Referring further to FIG. **11** a centralizer construction is shown which heretofore would have been impossible due to its extreme bulk but is made possible by this invention since it may be assembled on the well pipe at the well site. The centralizer **40** of FIG. **11** is substantially similar to centralizer **30** of FIG. **2** but with two additional tiers assembled between the upper and lower tiers with three common or middle collars **41**, **42** and **43** arranged similar to middle collar **32** with bows **13** extending in both directions therefrom. A factory assembled conventional centralizer similar to centralizer **40** would be 10 to 15 feet long thereby being completely impractical.

Referring now more particularly to FIG. **8** and **9**, there is illustrated a modified arrangement for releasably connecting the spring bow **50** to the arcuate segment **51** although the bow **50** and segments **51** are similar in all other respects to the heretofore described bows 13 and segments **14**. The arcuate segment **51** includes a large cutout portion **52**, a small cutout portion **53** and a bridge element **54** between such cutout portions. The end of bow **50** is provided with a flat portion **55** and

an outwardly turned end **56**. The cutout portions **52** and **53** are of a circumferential width adequate to receive the end of bow **50**. The bow **50** is assembled to the segment **51** by merely inserting the end of the bow through cutout portion **52**, behind bridge element **54** and then pivoting the end **56** of the bow out through the cutout portion **53** as shown in FIG. **9**. Once the plurality of bows **50** and segments **51** have been assembled to comprise a centralizer similar to centralizer **10** with all of the connecting hinge pins in place, the bows **50** will not become detached from the segments **51** since the required pivoting for disassembly cannot be accomplished in this assembled condition and end **56** engages the upper abutment edge of bridge element **54** to prevent withdrawal. By this arrangement the number of different components necessary to construct all sizes and types of centralizers is reduced even further since the various styles of bows **50** need not be assembled to the particular width of arcuate segment **51** until it is decided exactly the size and type centralizer desired for the particular situation.

A further modified form of releasable connection between the spring bow and arcuate segment similar to that shown in FIG. **8** and **9** is shown in FIG. **10**. In this embodiment the spring bow **60** is provided with straight end portion **65** but has hole **66** rather than the outwardly turned end **56** of the aforedescribed embodiment. The hole **66** may be of any desired shape. The arcuate segment **61** is again provided with a large cutout portion **62** and an outwardly deformed bridge portion **64**. The bridge portion **64** is provided with an inwardly deformed tab **67** of a shape for fitting the hole **66** in the bow **60**. The bow **60** is assembled to the arcuate segment **61** in a similar fashion by inserting the bow through cutout portion **62** and pivoting in a clockwise direction as viewed in FIG. **10** until the hole **66** is engaged by the abutment tab **67**. Again the bow **60** cannot be withdrawn from the segment **61** without pivoting which in turn cannot be accomplished after the bows and segments have been assembled into a centralizer. In all other respects the embodiment of FIG. **10** is the same as heretofore described embodiments and therefore has the same advantages.

Thus it may be seen that by this invention there is provided a novel form of centralizer and means for constructing same whereby an unlimited variety of sizes of centralizers can be assembled from a multiplicity of just a few different components. Although my invention has been described in connection with a few detailed embodiments it is to be understood that my invention is not limited to the herein disclosed details but rather is of the full scope of the appended claims.

I claim:

1. The combination of a centralizer and a well pipe comprising a pair of axially spaced and aligned collar means mounted on the well pipe, each collar means comprising of a multiplicity of more than two separate segments releasably connected together and encircling the well pipe, each segment being circumferentially curved to a predetermined radius of curvature and having a center of curvature radially displaced from the center of curvature of the outer surface of the well pipe and a plurality of outwardly bowed staves extending between and mounted on said collar means.

2. The combination of claim **1** wherein each said stave has one end mounted on one said segment of one collar means and the other end mounted on one said segment of the other collar means.

3. The combination of claim **2** wherein only one stave end is mounted on any said given segment.

4. A The combination of claim **1** wherein the radius of curvature of each said segment is approximately 3½inches.

5. The combination of claim **1** wherein at least four of said segments comprise each collar means and only three different circumferential widths form all diameters of collar means.

6. The combination of claim **1** in which said staves are releasably connected to said segments.

7. The combination of claim **6** in which each said segment to which a stave is connected has a cutout portion through which the stave extends, a bridge element over the stave and an abutment engaged by a portion of the stave for preventing withdrawal of the stave.

8. The combination of claim **1** in which each said segment has a circumferential extent of substantially less than 90° with respect to the said predetermined radius of curvature of said segment.

9. A centralizer for multiple sizes of well pipe comprising at least three axially aligned and spaced for producing at least two pairs of collar means with end collar means and common intermediate collar means, each collar means comprised of a multiplicity of more than two separate segments releasably connected together to encircle the well pipe, each segment being circumferentially curved to a predetermined radius of curvature for all of the multiple sizes of well pipe with said radius being within the range of radii of such multiple well pipe size, and a plurality of outwardly bowed staves extending between and mounted on each pair of collar means and extending in each direction from said intermediate collar means.

10. The centralizer of claim **9** in which only one stave is mounted on any given segment.

11. The combination of a centralizer device and a well pipe comprising, a multiplicity of more than two arcuate collar segments having longitudinal edges connected together into a collar of a size encircling the well pipe, each said collar segment being circumferentially curved to a predetermined radius of curvature and having a center of curvature radially displaced from the center of curvature of the outer surface of the well pipe, two said collars axially spaced and aligned, a plurality of outwardly bowed staves extending between and mounted on said collars, and at least some of said arcuate collar segments circumferentially wider than said staves and having a stave mounted thereon with only one stave mounted on a segment.

12. The combination of claim **11** wherein connecting elements are provided along each longitudinal edge of each segment with the elements along one edge opposite relative to the elements along the other longitudinal edge for comprising reversible and mating connecting sections.

13. The combination of claim **11** wherein for accomplishing said connection between segments each segment has one-half of a hinge section along each said longitudinal edge comprised of plural spaced and aligned tubular elements, and hinge pins join the adjacent hinge sections of the multiplicity of arcuate collar segments into each said collar.

14. The combination of claim **13** wherein the tubular elements along one longitudinal edge of each segment are offset relative to the tubular elements along the other longitudinal edge for comprising reversible and mating hinge sections.

15. A centralizer for any size well pipe whose external surface has a curvature within a predetermined range of curvatures employing a multiplicity of arcuate segments each having the same predetermined curvature which curvature is within said predetermined range of curvatures, and each having an arcuate extend of substantially less than 180° and means for circumferentially connecting the segments together and with a plurality of bowed spring staves each having one of such segments attached to each end, constructed by the method of, selecting at least three staves with attached segments, selecting an appropriate number of individual segments which are not attached to the ends of said staves to join with such selected stave segments at each end of the staves to form collars at each end of the staves of a size to encircle the particular well pipe on which the centralizer is to be mounted, and connecting together the selected nonattached segments and said attached segments to form spaced and aligned collars with the staves extending therebetween.