July 27, 1965 J. R. SOLUM 3,196,952

WELL PIPE CENTERING AND FLUID FLOW-COURSE CONTROLLING DEVICE

Filed June 20, 1962 3 Sheets-Sheet 1

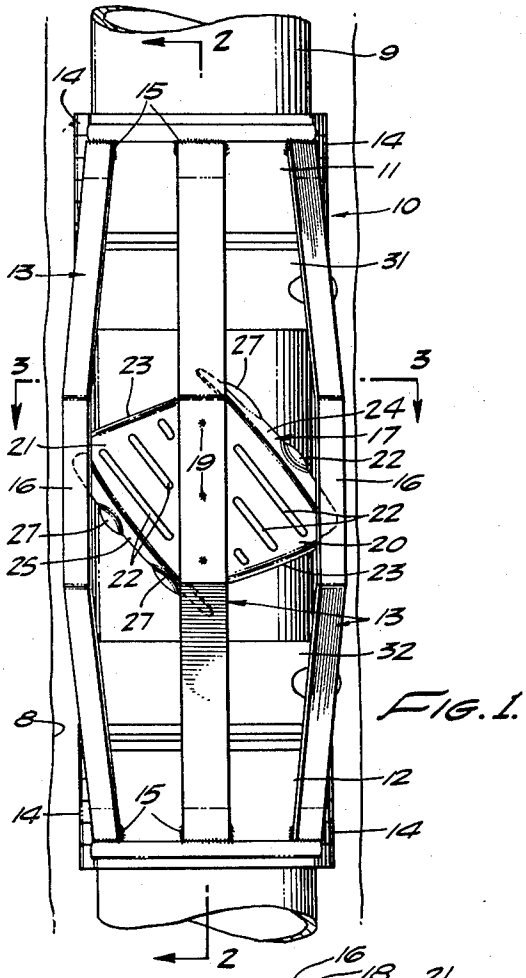


FIG. 1.

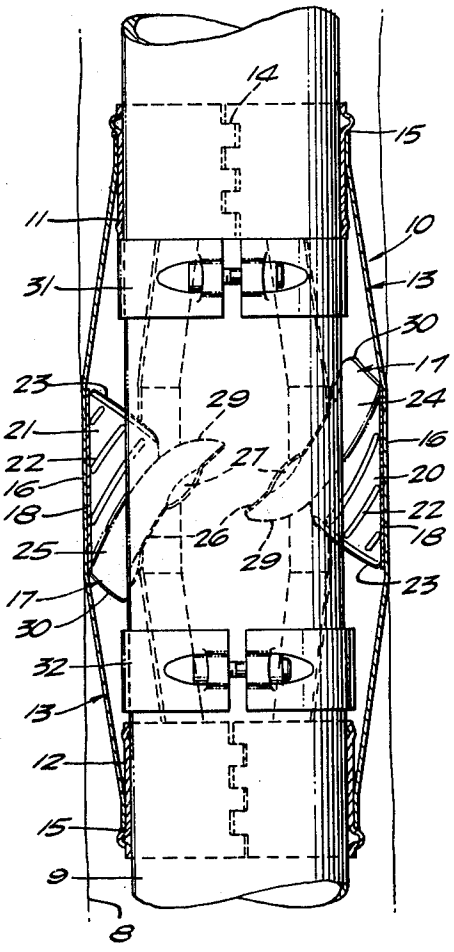


FIG. 2.

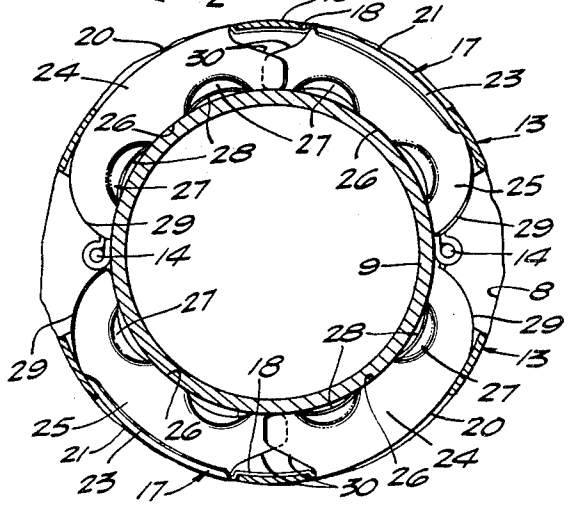


FIG. 3.

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WELL PIPE CENTERING AND FLUID FLOW-COURSE CONTROLLING DEVICE

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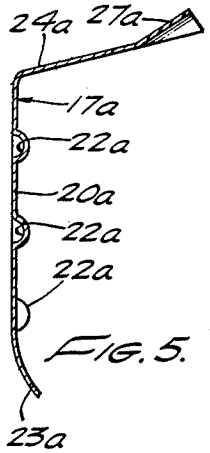


FIG. 5.

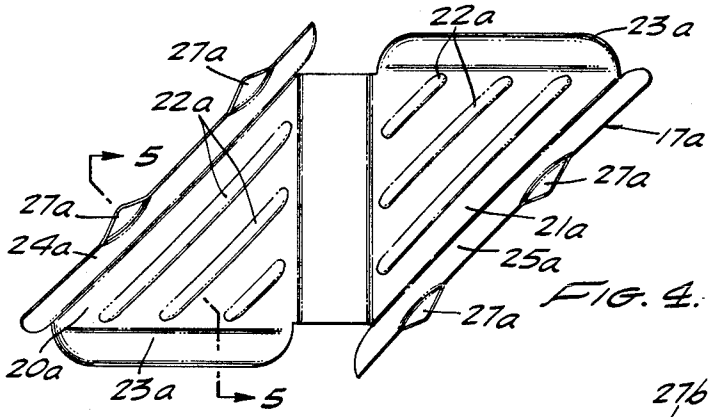


FIG. 4.

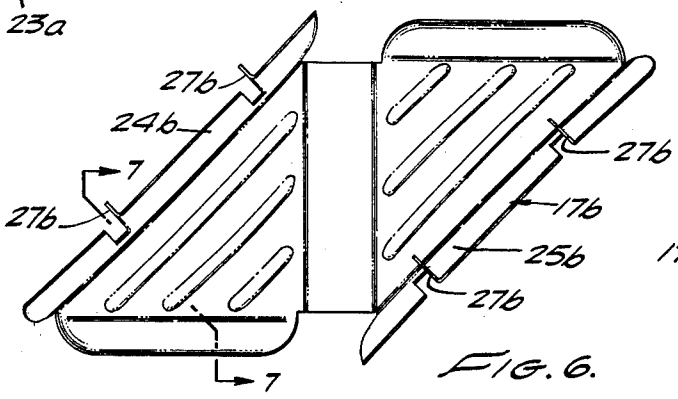


FIG. 6.

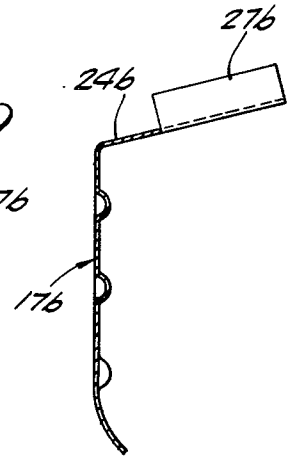


FIG. 7.

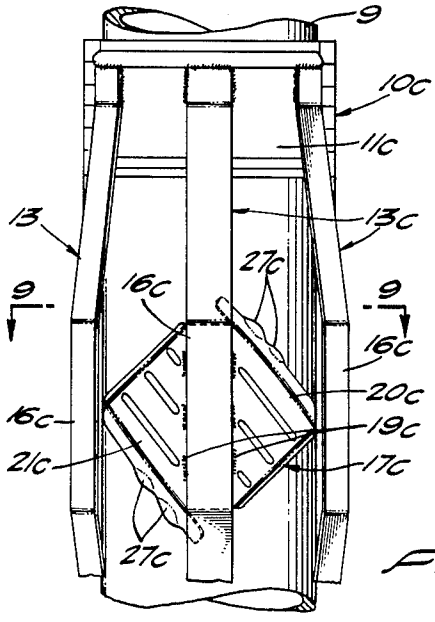


FIG. 8.

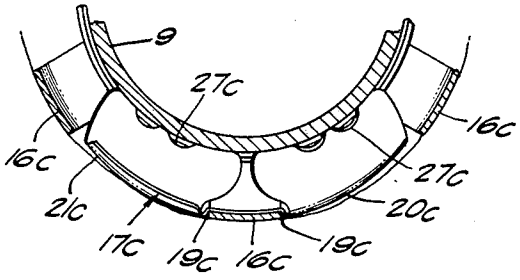


FIG. 9.

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WELL PIPE CENTERING AND FLUID FLOW-COURSE CONTROLLING DEVICE

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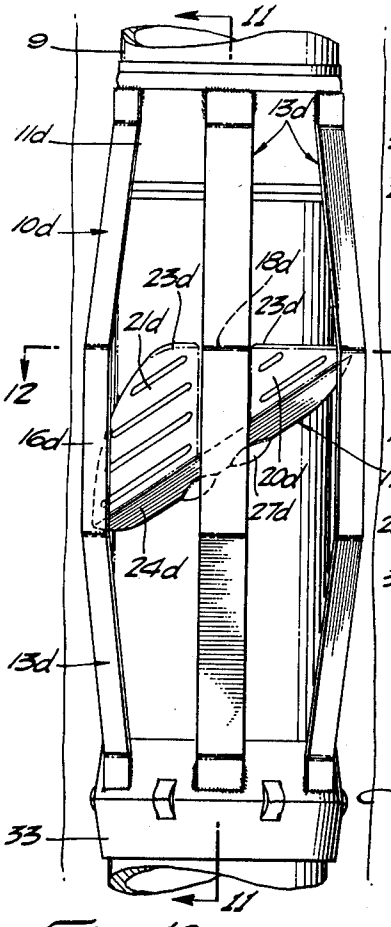


FIG. 10.

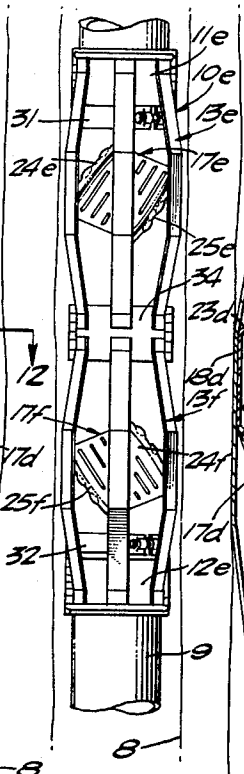


FIG. 14.

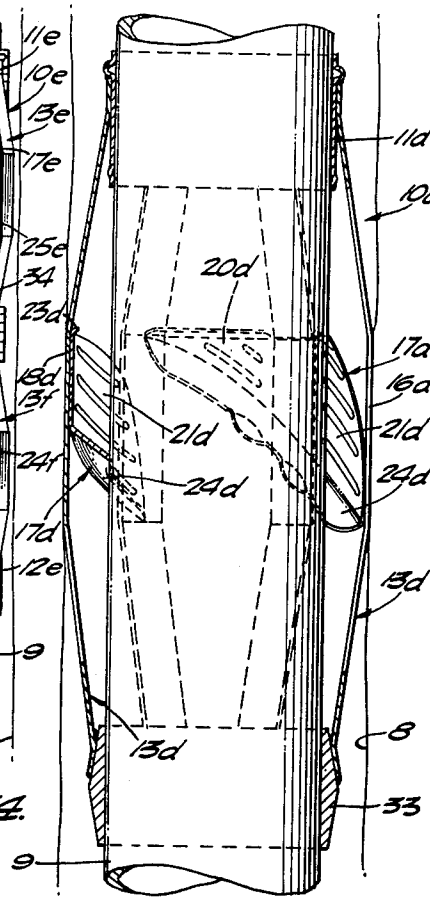


FIG. 11.

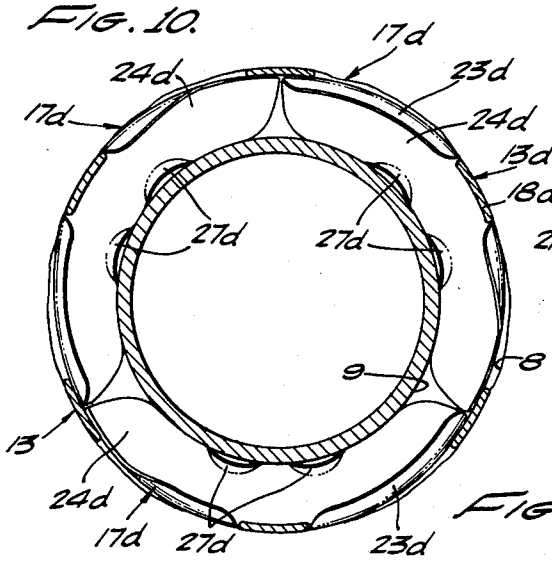


FIG. 12.

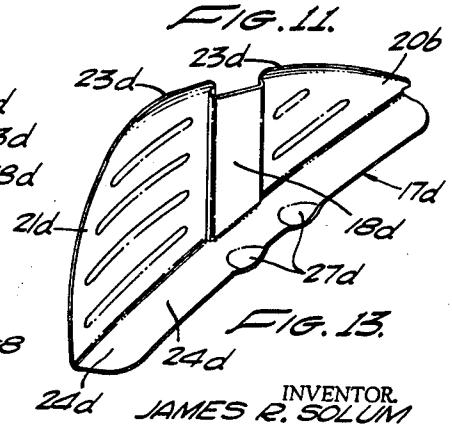


FIG. 13.

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3,196,952

WELL PIPE CENTERING AND FLUID FLOW-COURSE CONTROLLING DEVICE

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Filed June 20, 1962, Ser. No. 203,762
12 Claims. (Cl. 166—241)

This invention relates to a device for centering a well pipe in a well bore and directionally controlling the fluid flow past the device in the annular space between the well pipe and the wall of the well bore.

There are numerous processes and operations performed during the drilling and completion of oil or gas wells wherein a well casing, tubing or pipe is lowered into another larger well pipe or the well bore and where it is desirable to center the well pipe so lowered within the well bore of other well pipe. There are various types of devices employed for this purpose, some of which have outwardly bowed spring staves or bows and are commonly referred to as centralizers.

During the drilling and completion of wells, the well bore is generally filled with a drilling fluid or mud for various reasons. It has been found by those skilled in the art that when a well pipe is positioned within another well pipe or within the well bore and the drilling fluid or mud is circulated through the annular space therebetween, that the drilling fluid may assume a "channeling flow" through the annular space. In this channeling flow, only a portion of the fluid within the annular space is flowing relative to the well pipe and well bore and the remainder of the fluid remains relatively static. This channeling flow occurs as a result of the gelling properties of the drilling fluid or mud in that if the drilling fluid is allowed to stand in a static condition it will gel and a substantial hydraulic or mechanical agitating force is needed to again turn the drilling fluid into a flowing fluid state.

During certain procedures and processes in the drilling and completion of a well, such as cementing a well casing in the well bore this channeling flow is highly undesirable. For example, in a cementing operation if this channeling flow occurrs a complete displacement of the drilling fluid is not obtained and therefore the annular space will not be completely filled with cement and the well casing may not be adequately supported and cemented into the well bore. It has been found that hydraulic forces may be developed for eliminating this channeling flow by using extremely high fluid pumping velocities, but the pressures and volumes required have made such a method impractical due to the number of pumps required at the well site. The mechanical agitating force necessary to overcome the gelling of the drilling fluid has been achieved by the use of scratchers or the like on the exterior of the well casing and then rotating or reciprocating the casing to agitate the drilling fluid and cement slurry.

Accordingly, it is a principal object of this invention to provide a novel form of centralizer wherein novel means are provided for controlling the direction of flow of fluid past the centralizer to introduce turbulence and thereby interrupt the channeling flow occurring in the drilling fluid and cement slurry to develop a more complete displacement of the drilling fluid by the cement slurry.

Another object of this invention is to provide such a novel form of centralizer wherein each means for controlling the fluid flow-course in the annular space are supported by and extend circumferentially from either side of a centralizer bow; and such means are adapted to collapse or expand as the bows are collapsed or expanded to conform to the configuration of the well bore.

A further object of this invention is to provide a centralizer with novel means that cooperate with the well casing to define a substantially enclosed fluid passage positioned at an angle to the axis of the well pipe whereby the fluid flow-course passed the centralizer is controlled to interrupt any channeling flow occurring in the annulus.

Another object of this invention is to provide a fluid flow-course controlling device for agitating the drilling fluid and cement slurry present within the annular space between a well pipe and the well bore wall wherein novel means are provided and adequately supported for conforming to the size and configuration of the well bore without damage to the well bore wall or the device.

A further and more specific object of this invention is to provide a device for centering a well pipe and controlling the flow-course of fluid past the device wherein the flow-course of the fluid is directed helically in one direction around the well pipe at one location on the device and is directed helically around the pipe in the opposite direction at a second point longitudinally spaced from the first point.

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

In the drawings:

FIGURE 1 is an elevation view illustrating the device of this invention mounted on a well pipe and positioned in a well bore.

FIGURE 2 is a sectional elevation view taken substantially on the line 2—2 as shown in FIGURE 1.

FIGURE 3 is a sectional plan view taken substantially on the line 3—3 as shown in FIGURE 1.

FIGURE 4 is an elevation view showing a modified form of the fluid flow-course element employed in the device of this invention.

FIGURE 5 is a sectional view taken substantially on the line 5—5 as shown in FIGURE 4.

FIGURE 6 is a second modified form of the fluid flow-course element employed in the device of this invention.

FIGURE 7 is a sectional view taken substantially on the line 7—7 as shown in FIGURE 6.

FIGURE 8 is a fragmentary elevation view of the device of this invention illustrating a modified form of the fluid flow-course element which may be employed.

FIGURE 9 is a fragmentary sectional plan view taken substantially on the line 9—9 as shown in FIGURE 8.

FIGURE 10 is an elevation view of another modified form of the device of this invention shown mounted on a well pipe and positioned in a well bore.

FIGURE 11 is a sectional elevation view taken substantially on the line 11—11 shown in FIGURE 10.

FIGURE 12 is a sectional plan view taken substantially on the line 12—12 shown in FIGURE 10.

FIGURE 13 is a perspective view of the fluid flow-course element employed in the modified form of device shown in FIGURES 10, 11 and 12.

FIGURE 14 is an elevation view of another modified form of the device of this invention which may employ one or more features of the other forms of this invention.

Referring now to FIGURES 1, 2 and 3 the device of this invention, generally designated **10**, is provided with a pair of axially aligned and spaced collars **11** and **12** and a plurality of longitudinally extending spring bows **13**. The collars **11** and **12** may each be in the form of a pair of semi-cylindrical collars hinged together by hinges **14** as shown or the collars may be solid cylindrical collars (not shown). As is conventional with centralizers and the like, if the collars **11** and **12** are hinged the device **10** may be hinged to an open position and laterally applied to the casing **9** whereas if the collars are solid the device must be slipped on the casing **9**.

The spring bows **13** extend longitudinally between col-

lars **11** and **12** and are secured thereto by any convenient means such as arc welding **15**. As is conventional with centralizers, the spring bows **13** are bowed outwardly from the collars and the casing **9** in order to engage the well bore wall **8** for maintaining the casing **9** substantially in the center of the well bore. The spring bows **13** of this device are preferably provided with a longitudinally straight portion **16** for establishing surface contact with the well bore wall **8** and for mounting a flow-course element, generally designated **17**, thereon.

As shown in FIGURES 1, 2 and 3 the flow-course element **17** is an integrally formed assembly provided with a channel shaped mounting base **18** adapted to fit inside of the straight portion **16** of a spring bow **13**. The mounting base **18** is secured to the straight portion **16** by any convenient means such as spot welding **19**. Plates **20** and **21** project laterally and circumferentially from the mounting base **18** and have a generally cylindrical outer surface for engaging the well bore wall **8**. The outer surface of the plates **20** and **21** may be provided with one or more linear depressions **22** which form inwardly projecting ribs to enhance the structural strength of the plates **20** and **21**. The linear depressions **22** also serve to reduce the tendency of the outer surfaces of the plates **20** and **21** to adhere to the well bore wall **8**. The lower edge of plate **20** and the upper edge of plate **21** are each provided with an inwardly curved lip **23** to prevent the plates **20** or **21** from gouging or excessively scraping the well bore wall **8** upon longitudinal movement of the device **10** relative to the well bore wall. Inwardly projecting vanes **24** and **25** are provided on the plates **20** and **21**, respectively.

The vanes **24** and **25** each extend diagonally at an angle to both the attached spring bow **13** and the circumference of the well pipe **9** as best shown in FIGURE 1. Each of the vanes **24** and **25** project inwardly toward the well casing **9** at an angle to the surface of the well casing rather than perpendicular thereto so that as the attached spring bow **13** is compressed toward the well casing the vanes **24** and **25** will flex relative to the plates **20** and **21**, respectively, rather than be crushed by this inward movement of the spring bow. The vanes **24** and **25** each have an edge **26** along their inwardly projecting extremity which is contoured to substantially fit and engage the outer surface of the well casing **9**. The vanes **24** and **25** may also be provided with one or more formed ribs **27** protruding from the major surface of the vane with an edge **28** slightly spaced from the outer surface of the well casing **9**. A small aperture is formed between the edge **28** of the vane and the surface of the well casing for fluid to pass therebetween. The ribs **27** may be intentionally formed in the vanes **24** and **25** or may occur as a result of the forming of vanes **24** and **25** since these vanes are relatively flat but must be formed to curve around the well casing. The vanes **24** and **25** of a single flow-course element **17** preferably extend at equal diagonal angles relative to the attached spring bow **13**. Thus a diagonally directed fluid flow-course is formed between the vanes **24** and **25** of a single element **17** and such flow-course is substantially equal in cross-section throughout its length. The ends of the vanes **24** and **25** are curved from the plates **20** and **21**, respectively, toward the edge **26** as shown at **29** and **30** so that the vanes will not engage and gouge the well bore wall **8**.

In the form of device **10** shown in FIGURES 1, 2 and 3, the plates **20** and **21** and vanes **24** and **25** extend circumferentially from the attached spring bow **13** to a location underneath each adjacent spring bow **13**. Thus, each flow-course element **17** is positioned between three spring bows **13** and the well casing **9**. As the device **10** passed through a restricted portion of the well bore or the casing **9** is urged off center relative to the well bore as in a non-vertical directional well bore, the bow springs **13** will be urged inwardly toward the well casing **9** and the vanes **24** and **25** will be flexed to accommodate the change in annular space. As shown in the plan view FIGURE 3, the vanes **24** and **25** of a single flow-course element **17** overlap one another under the attached spring bow **13** as shown at **30**. In the form of the device **10** shown in FIGURES 1, 2 and 3 where six spring bows **13** are provided and equally spaced around the collars **11** and **12**, it is preferred that two flow-course elements **17** be provided and secured to diametrically spaced spring bows **13**. By providing two elements **17** the vane **24** of one element and the vane **25** of the other element form a fluid flow-course therebetween as shown in FIGURE 2 which is similar to the flow-course between vanes **24** and **25** of a single flow-course element **17**, but is open to the well bore wall **8**.

The device **10** may be positioned on the well casing **9** at the desired location by any convenient means such as a pair of stop collars **31** and **32** which may be of the type shown in United States Letters Patent No. 2,983,982, entitled Friction Clamp Collar, issued May 16, 1961. As shown in FIGURE 1, stop collar **31** may engage the lower edge of collar **11** and stop collar **32** will be slightly spaced from the upper edge of collar **12**. Although it is usually adequate to provide a single stop collar between the collars of a centralizer it is necessary to provide the two stop collars **31** and **32** with device **10** so that the collars **11** and **12** cannot move far enough on the casing **9** for the vanes **24** and **25** to engage the stop collars which, if permitted, may damage the vanes. The casing **9** with one or more devices **10** installed thereon (and conventional scratchers, if desired) is lowered into the well bore. As the device **10** passes through the well bore, the drilling fluid or mud in the annular space between the casing and the well bore wall is forced to pass through the flow-courses defined by vanes **24** and **25** to thereby mechanically agitate any gelled drilling fluid to a more fluid state. Likewise, when the drilling fluid or cement slurry is pumped down through the well casing **9** and upwardly in the annular space the upward direction of flow will be diagonally diverted by the vanes **24** and **25** thereby hydraulically agitating and creating turbulence in the drilling fluid and cement slurry.

The modified form of flow-course element, generally designated **17*a***, shown in FIGURES 4 and 5 is similar to the flow-course element **17** shown in FIGURES 1, 2 and 3 except that the shape of the circumferentially extending plates **20*a*** and **21*a*** modified from the shape of the plates **20** and **21**. The inwardly curved lips **23*a*** on each plate **20*a*** and **21*a*** extend substantially circumferentially rather than diagonally as do lips **23** of plates **20** and **21**. FIGURES 4 and 5 also show linear depressions **22*a*** in the surfaces of plates **20*a*** and **21*a*** and ribs **27*a*** in the vanes **24*a*** and **25*a*** similar to the linear depressions **22** and ribs **27** shown in FIGURES 1, 2 and 3.

The modified form of flow-course element, generally designated **17*b*** shown in FIGURES 6 and 7, may be substantially similar to the flow-course elements **17** and **17*a*** shown in FIGURES 1 through 5 except that one or more tabs **27*b*** are lanced out of the vanes **24*b*** and **25*b*** rather than providing the ribs **27** or **27*a*** in the vanes. The tabs **27*b*** serve as a turbulence generating obstruction in the flow-courses formed by the vanes **24*b*** and **25*b*** to thereby further agitate the drilling fluid and cement slurry passing through such flow-courses. Moreover, the aperture formed by lancing the tabs **27*b*** out of the material of the vanes **24*b*** and **25*b*** allow drilling fluid and cement slurry to pass therethrough at an angle to the major direction of fluid flow to further hydraulically agitate the flowing drilling fluid and cement slurry.

The modified form of the device generally designated **10*c*** shown in FIGURES 8 and 9, is provided with axially spaced collars **11*c*** (lower collar not shown) and longitudinally extending spring bows **13*c*** similar to collars **11** and **12** and spring bows **13**, respectively, provided in the device **10** shown in FIGURES 1, 2 and 3. The flow-course element, generally designated **17*c***, of this modified form is similar to flow-course element **17** except that the circumferentially extending plates **20*c*** and **21*c*** extend a

shorter distance than the plates 20 and 21 so that plates 20c and 21c are not positioned beneath the adjacent spring bows 13c, as best shown in FIGURE 9. This arrangement allows freer movement of the plates 20c and 21c and the adjacent spring bows 13c but also eliminates the backup support for the element 17c which would be provided by these spring bows. FIGURES 8 and 9 also illustrate that the flow-course element 17c may be secured to the straight portion 16c of the spring bow by means of arc welding 19c rather than the spot welding 19 used in device 10. Further, FIGURES 8 and 9 show that the projections 27c may be located at any point along the inwardly directed vanes as desired.

The modified form of device, generally designated 10d, shown in FIGURES 10, 11, 12 and 13 is provided with an upper collar 11d and a lower collar 33 with a plurality of spring bows 13d extending therebetween and secured to the collars. The lower collar 33 is adapted to be secured to the well pipe 9 and may be of any conventional type stop collar such as that shown in United States Letters Patent No. 2,872,226, entitled Stop Collar for a Well Pipe, issued February 3, 1959. By providing the stop collar 33 it is unnecessary to provide the stop collars 31 and 32 shown in FIGURES 1 and 2. Three flow-course elements, generally designated 17d, are provided on the device 10d and the elements preferably are mounted on the longitudinally straight portions 16d of every other spring bow 13d (when six spring bows are provided, as shown). Each flow-course element 17d has a mounting base 18d and a pair of plates 20d and 21d extending circumferentially in opposite directions from the mounting base. The plates 20d and 21d may be provided with inwardly curved lip portions 23d along their upper edges similar to previously described lips 23 and 23a. A single vane 24d is provided on each flow-course element 17d and projects inwardly toward the surface of the casing 9 from and is integrally formed with the plates 20d and 21d and the mounting base 18d. The vane 24d extends diagonally at an angle to both the spring bow 13d and the circumference of the well casing 9, as best shown in FIGURE 10. Although it is not essential it is preferred that the plates 20d and 21d and the vane 24d extend circumferentially underneath both of the spring bows 13d adjacent to the attached spring bow 13d to thereby provide additional support to the flow-course element 17d. Since the flow-course elements 17d are secured to every other spring bow 13d and each element extends circumferentially underneath each adjacent spring bow 13d the vanes 24d of separate elements 17d either overlap or nearly overlap as shown in FIGURE 12. Thus, a fluid flow-course is defined between the vanes 24d of adjacent flow-course elements 17d. Projections 27d may be provided on the vane 24d similar to projections 27 on device 10 of FIGURES 1, 2 and 3 for the same purposes.

In the modified form of device, generally designated 10e, shown in FIGURE 14, an upper collar 11e, a lower collar 12e, and a middle collar 34 are provided and are axially spaced and aligned. A plurality of spring bows 13e extend longitudinally between and are secured to collars 11e and 34. A second plurality of spring bows 13f extend longitudinally between and are secured to collars 12e and 34. Flow-course elements 17e and 17f are provided and mounted on spring bows 13e and 13f, respectively, in a manner as previously described. The number of elements 17e that are spaced around the device 10e and mounted to spring bows 13e, and likewise, the number of elements 17f that are spaced around device 10e and mounted to spring bows 13f will depend upon the particular design of elements 17e and 17f, the number of spring bows 13e and 13f, and design choice. The flow-course elements 17e and 17f may be of any of the types of flow-course elements previously described. The vane or vanes 24e and 25e of elements 17e are diagonally positioned in one direction relative to the well casing 9 and the spring bows 13e while the vane or vanes 24f and 25f of elements 17f are diagonally positioned in the opposite direction. Thus the drilling fluid and cement slurry flowing past the device 10e in the annular space between the casing 9 and well bore wall 8 is first forced to flow in one helical direction (such as left-handed, by element 17f) and then in the opposite helical direction (right-handed, by element 17e). This reversing of direction of flow serves to more effectively change the drilling fluid to a more fluid state and therefore further reduces the channeling flow of the drilling fluid within itself. Moreover, when the ascending cement slurry flows past the device 10e the oppositely directed vanes on elements 17e and 17f further enhance the complete displacement of the drilling fluid by the cement slurry. The device 10e may be positioned on casing 9 by mounting a stop collar 31 on the casing just below the upper collar 11e and mounting a stop collar 32 on the casing just above the lower collar 12e, as described relative to FIGURE 1, or in any other conventional manner.

Thus it may be seen that a device is provided, having various modifications, which effectively centers the well casing within the well bore, effectively agitates and creates turbulence in the drilling fluid and cement slurry by flow-course control, and adapts itself to the size and configuration of the well bore without damage to the device. It is to be noted that each of the flow-course elements shown and described herein is supported at or near the center of the element with a vane or portion of a vane extending circumferentially in either direction from the attached spring bow. Thus as that attached spring bow is compressed in the well bore the flexing forces on the vanes are relatively equally distributed on each side of the support base of the flow-course element thereby minimizing any possibility of structural failure.

Having fully described my invention it is to be understood that I do not wish to be limited to the details herein set forth or to the details illustrated in the drawings, but my invention is of the full scope of the appended claims.

I claim:

1. In a well pipe centering and fluid flow-course controlling device the combination of: a plurality of axially spaced collars adapted to be mounted on the well pipe, a plurality of outwardly bowed spring means extending between and secured to said collars, plate means mounted on said spring means and extending circumferentially in both directions from that spring means to locations beneath each of the circumferentially adjacent spring means for confining the circumferential extremities of said plate means between said adjacent spring means and the well pipe, said plate means having at least one vane projecting inwardly from said spring means toward the well pipe, each said vane extending diagonally and circumferentially relative to the well pipe for diverting fluid flowing past the device, and each said vane being resilient for flexing upon flexing of said spring means.

2. The combination of claim 1 wherein means are provided on one of said collars for securing that collar to the well pipe.

3. In a well pipe centering and fluid flow-course controlling device, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of outwardly bowed spring means extending between and secured to said collars, a plurality of flow-course controlling means, each said flow-course controlling means mounted on the inside of a said spring means and extending laterally in both directions from that spring means, each flow-course controlling means having at least one vane projecting inwardly toward and engaging the surface of the well pipe, each said vane having at least one projection thereon shaped away from the casing for forming a gap between the vane and the surface of the well pipe, and each vane extending diagonally and circumferentially relative to the well pipe and said spring means in substantially the same relation as the other vanes

for defining a flow-course between each pair of vanes, said vanes being resilient for flexing upon flexing of said spring means.

4. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly for engaging the well bore, a plurality of flow-course elements, each flow-course element mounted on the inside of a spring bow and extending circumferentially in both directions to locations beneath each of the circumferentially adjacent spring bows for confining the circumferential extremities of said flow-course element between said adjacent spring bows and the well pipe, each flow-course element having a pair of vanes projecting inwardly toward and at an angle to the surface of the well pipe, each said vane extending diagonally and circumferentially relative to the spring bows and to the well pipe, the pair of said vanes on one flow-course element extending diagonally and circumferentially at substantially the same angle whereby an enclosed fluid passage is formed therebetween, and each said vane having an edge along the inwardly projecting extremity for engaging and conforming to the surface of the well pipe, said vanes being resilient for flexing upon flexing of said spring bows.

5. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, one of said collars having means for securing that collar to the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly for engaging the well bore, a plurality of flow-course elements, each flow-course element mounted on the inside of a spring bow and extending circumferentially in both directions to locations beneath each of the circumferentially adjacent spring bows for confining the circumferential extremities of said flow-course element between the well pipe and the said adjacent spring bows, each flow-course element having a pair of vanes projecting inwardly toward and at an angle to the surface of the well pipe, said vanes being resilient for flexing upon flexing of said spring bows, each said vane extending circumferentially and diagonally relative to the spring bows and to the well pipe, the pair of said vanes on one flow-course element extending diagonally at substantially the same angle whereby an enclosed fluid passage is formed therebetween, and each said vane having an edge along the inwardly projecting extremity for engaging and conforming to the surface of the well pipe.

6. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly for engaging the well bore, a plurality of flow-course elements, each flow-course element having a base portion mounted on the inside of a spring bow, each flow-course element having a plate extending circumferentially from said base portion in one direction and another plate extending circumferentially from said base portion in the other direction, each said plate extending circumferentially to a location beneath the next adjacent spring bow for confining the circumferential extremity of that said plate between that said adjacent spring bow and the well pipe, a vane on each said plate projecting inwardly toward and at an angle to the surface of the well pipe, said vanes being resilient for flexing upon flexing of said spring bows, each said vane extending circumferentially and diagonally relative to the spring bows and to the well pipe, the pair of said vanes on one flow-course element extending diagonally at substantially the same angle, each said vane having an edge along the inwardly projecting extremity for engaging and conforming to the surface of the well pipe, and the said vanes and plates of each flow-course element cooperating with the surface of the well pipe to define an enclosed fluid passage extending diagonally relative to the well pipe.

7. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly for engaging the well bore, a plurality of flow-course elements, each flow-course element having a base portion mounted on the inside of a spring bow, each flow-course element having a plate extending circumferentially from said base portion in one direction and another plate extending circumferentially from said base portion in the other direction, a vane on each said plate projecting inwardly toward and at an angle to the surface of the well pipe, said vanes being resilient relative to the attached plate for flexing of such vane upon flexing of the said spring bows, each said vane extending circumferentially and diagonally relative to the spring bows and to the well pipe, the pair of said vanes on one flow-course element extending diagonally at substantially the same angle, each said vane having an edge along the inwardly projecting extremity for engaging and conforming to the surface of the well pipe, each said edge having a tab lanced therefrom for forming a gap between said edge and the well pipe surface for permitting fluid flow therebetween, and the said vanes and plates of each flow-course element cooperating with the surface of the well pipe to define an enclosed fluid passage extending diagonally relative to the well pipe.

8. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly for engaging the well bore and having an intermediate longitudinally extending straight portion, a plurality of flow-course elements, each flow-course element having a base portion mounted on the said straight portion of a spring bow, each flow-course element having a plate extending circumferentially from said base portion in one direction and another plate extending circumferentially from said base portion in the other direction, a vane on each said plate projecting inwardly toward and at an angle to the surface of the well pipe, said vanes being resilient relative to the attached plate for flexing upon flexing of said spring bows, each said vane extending circumferentially and diagonally relative to the spring bows and to the well pipe, the pair of said vanes on one flow-course element extending diagonally at substantially the same angle, each said vane having an edge along the inwardly projecting extremity for engaging and conforming to the surface of the well pipe, each said vane having at least one projection thereon shaped away from the well pipe for separating that portion of each said edge from the well pipe surface for permitting fluid flow therebetween, and the said vanes and plates of each flow-course element cooperating with the surface of the well pipe to define an enclosed fluid passage extending diagonally relative to the well pipe.

9. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: a pair of axially spaced collars adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to said collars, each of said spring bows being bowed outwardly from engaging

the well bore and having an intermediate longitudinally extending straight portion, a plurality of flow-course elements, each flow-course element having a base portion mounted on the said straight portion of a spring bow, each flow-course element having a plate extending circumferentially from said base portion in one direction and another plate extending circumferentially from said base portion in the other direction, each said plate having one edge with an inwardly curved lip and another edge with an integral vane, each vane projecting inwardly toward and at an angle to the surface of the well pipe, said vanes being resilient relative to said plate for flexing upon flexing of said spring bows, each said vane extending laterally at an angle to the spring bows and at an angle to the circumference of the well pipe, the pair of said vanes on one flow-course element extending laterally at substantially the same angle, each said vane having an edge along the inwardly projecting extremity of engaging and conforming to the surface of the well pipe, each said vane having at least one projection thereon shaped away from the well pipe for separating that portion of each said edge from the well pipe surface for permitting fluid flow therebetween, and the said vanes and plates of each flow-course element cooperating with the surface of the well pipe to define an enclosed fluid passage extending at an angle to the axis of the well pipe.

10. In a device for centering a well pipe in a well bore and controlling the flow-course of fluid in the annular space between the well pipe and the well bore, the combination of: an upper collar, a middle collar, a lower collar, said collars being axially aligned and spaced and adapted to be mounted on the well pipe, a plurality of spring bows extending between and secured to the upper and middle collars, a second plurality of spring bows extending between and secured to the lower and middle collars, each of said spring bows being bowed outwardly for engaging the well bore, a plurality of flow-course elements, at least one of said flow-course elements mounted on one of the spring bows of said first plurality of spring bows and

at least another of said flow-course elements mounted on one of the spring bows of said second plurality of spring bows, each said flow-course element having at least one vane projecting inwardly toward the well pipe, said vanes being resilient relative to said element for flexing upon flexing of said spring bows, each said vane extending circumferentially and diagonally relative to the spring bows and the well pipe, each said flow-course element extending circumferentially in both directions from the attached spring bow to locations beneath both of the circumferentially adjacent spring bows for confining the circumferential extremities of said flow-course element between said adjacent spring bows and the well pipe, and the said vanes on the flow-course elements mounted on said first plurality of spring bows extending diagonally in the opposite direction as the said vanes on the said second plurality of spring bows.

11. The combination of claim 10 wherein two said vanes are provided on each said flow-course element and the said two vanes on each individual element are substantially parallel and spaced from each other to define a flow-course therebetween.

12. The combination of claim 10 wherein each said vane projects inwardly at an angle to the surface of the well pipe and has an edge substantially conforming to and engaging the well pipe.

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