

April 14, 1959

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2,881,840

TOOL FOR USE IN CEMENTING WELL CASING

Filed March 26, 1956

4 Sheets-Sheet 1

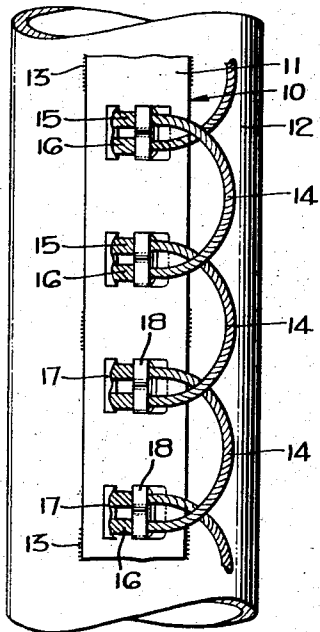


FIG. 1.

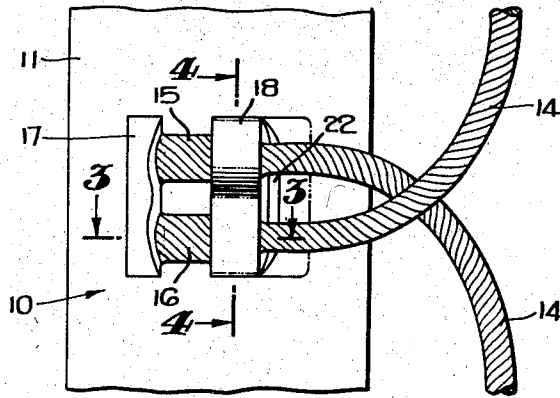


FIG. 2.

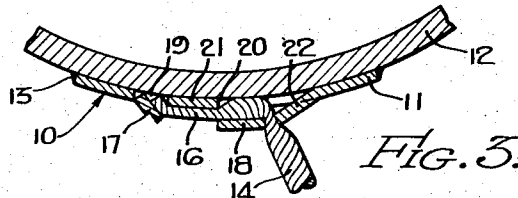


FIG. 3.

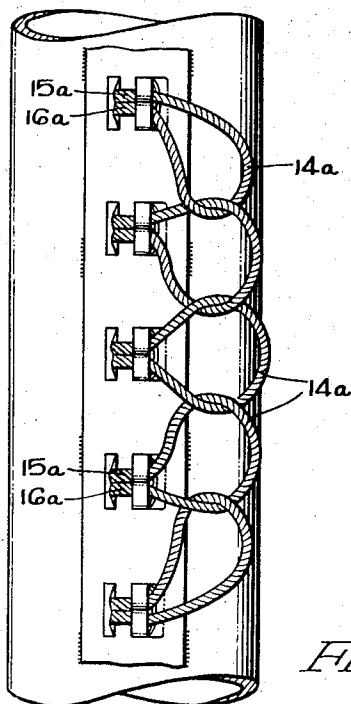


FIG. 5.

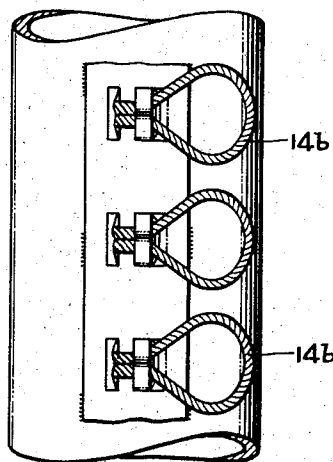


FIG. 6.

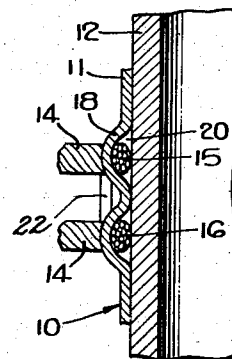


FIG. 4.

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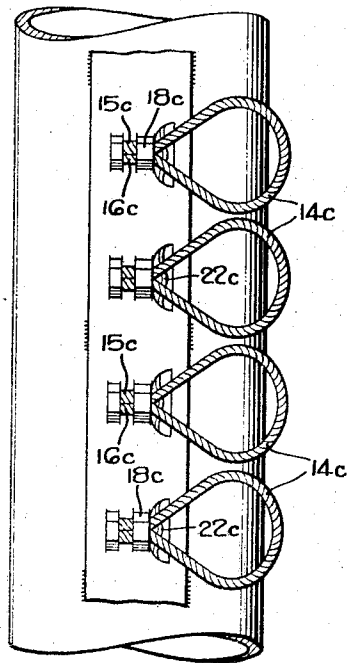


FIG. 7.

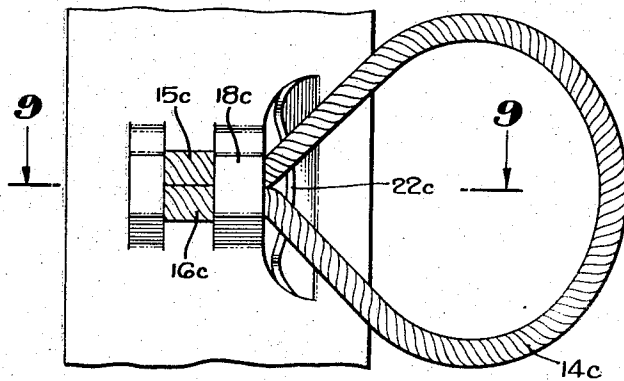


FIG. 8.

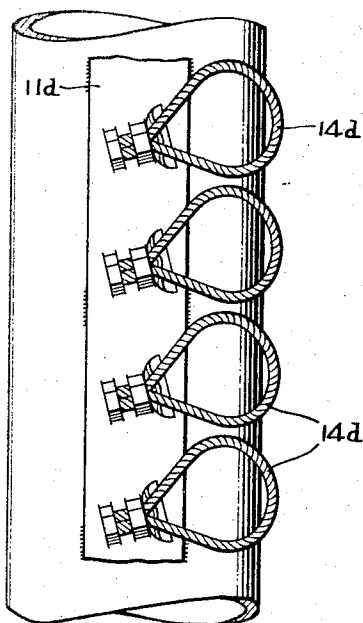


FIG. 10.

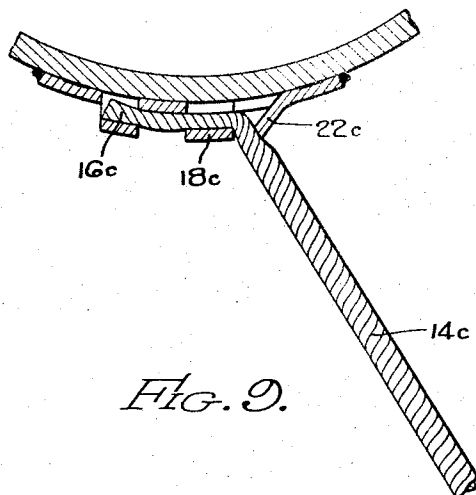


FIG. 9.

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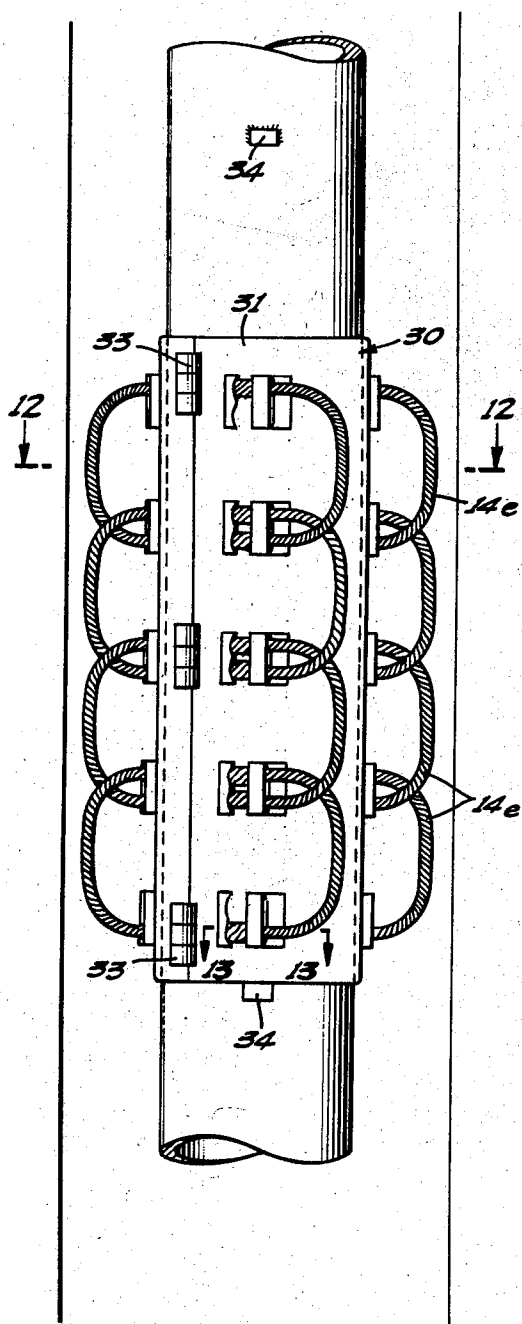


FIG. 11.

FIG. 12.

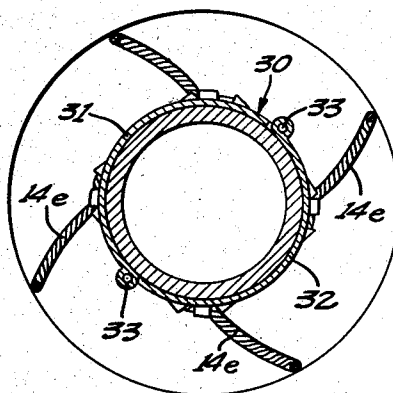
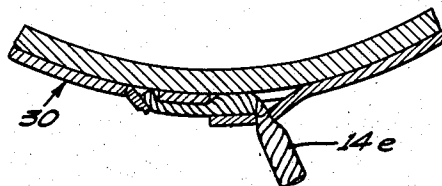


FIG. 13.



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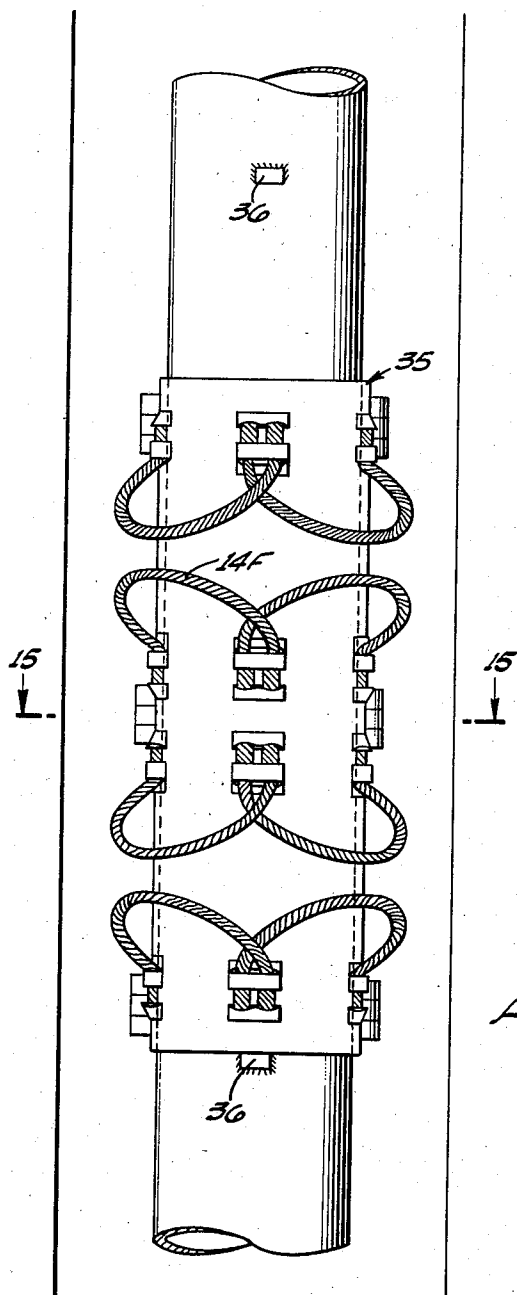


FIG. 14.

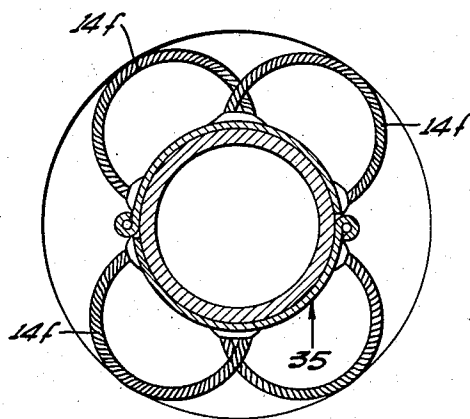


FIG. 15.

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TOOL FOR USE IN CEMENTING WELL CASING

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Application March 26, 1956, Serial No. 573,909

9 Claims. (Cl. 166—173)

This invention relates to well drilling and completion apparatus and is particularly directed to improvements in devices for creating turbulence in the annular space between the well casing and the walls of the well formation during cementing operations.

It is highly desirable to displace substantially all of the drilling mud in the annular space in order to obtain a cement bond of optimum quality between the well casing and the walls of the formation. In order to obtain such full displacement, however, it is essential to create turbulence in the mud column. Without turbulence, the cement slurry fails to displace the mud fully, and on the contrary forms channels or small passageways in the annular space, and the resulting cement shut-off is defective. Turbulence can be created in the annular space if sufficient velocity is imparted to the cement slurry entering the lower end of the annular space. However, the required velocity is so high as to make it almost impossible to achieve with conventional cement pumping equipment located at the ground surface.

Well scratchers are commonly used in oil well completion practice and when these are mounted on the casing, they serve to create turbulence in the annular space when the casing string is rotated. However, the cost of the commercial forms of such scratcher devices has been an important factor in limiting their use to the lowermost section of the casing string.

It is desirable that devices which are mounted on the outer surface of the casing sections be installed before the casing sections are moved into the derrick or mast and connected end-to-end and, therefore, the devices must be capable of withstanding severe handling treatment when they are attached to casing sections resting on horizontal pipe racks. The carrier strips which serve to mount the devices on the outer surface of the casing sections must ordinarily be applied while the casing sections are on the horizontal pipe racks adjacent the mast or derrick. Handling of the casing sections entails rolling of one pipe section against another with the result that the mounted devices may be permanently damaged.

Accordingly, it is the principal object of this invention to provide a novel form of well cementing tool for creating turbulence in the annular space containing the mud column, and which tool is particularly adapted to withstand severe treatment when the casing sections with the devices installed thereon are placed on pipe racks in contact with each other.

Another object of this invention is to provide a turbulence generator which may be fixed to the casing and which includes novel elements in the form of loops of multiple strand flexible wire cable arranged to project at an angle from the casing into the annular space within the walls of the formation.

Another object is to provide a well tool device of this type adapted to be mounted on a carrier strip and wherein the ends of the cable loops are secured to the carrier strip in a novel manner.

Another object is to provide a well tool device of this

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type in which the operation of fastening the ends of the wire loops to the carrier strip may be performed in punch press operations for economy of manufacture on a quantity production basis.

Another object is to provide a turbulence generator which may comprise multiple strand flexible wire cables mounted on a collar free to move on the well casing. Stops are preferably provided to limit the extent of relative axial movement of the collars on the casing.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 shows a fragmentary length of a well tool device constituting a preferred embodiment of my invention.

Figure 2 is an enlarged detail of a portion of Figure 1.

Figure 3 is a transverse sectional view taken substantially on the lines 3—3 as shown in Figure 2.

Figure 4 is a longitudinal sectional view taken substantially on the lines 4—4 as shown in Figure 2.

Figure 5 is a view similar to Figure 1, showing a modification.

Figure 6 shows a second modification.

Figure 7 shows a third modification.

Figure 8 is an enlarged view of a portion of Figure 7. Figure 9 is a sectional view taken substantially on the lines 9—9 as shown in Figure 8.

Figure 10 shows a fourth modification.

Figures 11, 12 and 13 show another modification.

Figure 12 is a sectional view taken substantially on line 12—12 as shown in Figure 11.

Figure 13 is a sectional detail on an enlarged scale and taken substantially on line 13—13 as shown in Figure 11.

Figures 14 and 15 show another modification.

Figure 15 is a sectional view taken substantially on line 15—15 as shown in Figure 14.

Referring to the drawings, the turbulence generator device generally designated 10 includes a carrier strip 11 which may be fixed to the outer surface of the well casing 12 by any convenient means, for example, by weld metal 13. The carrier strips 11 may be of any convenient length and are preferably mounted on each length of casing making up the casing string.

The elements which extend into the annulus outside the casing are formed of multiple strand flexible wire cable in the form of loops 14 having ends 15 and 16 fixed to the carrier strip at longitudinally spaced locations. As shown in the drawings, the ends of the cable loops 14 are staggered so that the lower end of one loop overlaps the upper end of the next adjacent loop. The cable ends are thus secured in pairs to the carrier strip 11.

A pair of laterally spaced bridge elements 17 and 18 are lanced from the sheet material of the carrier strip 11 and are bent to define apertures 19 and 20, respectively, through which the cable ends are inserted. A central undistorted "land" portion 21 remains between the bridge elements 17 and 18. The cable ends 15 and 16 are inserted laterally into the apertures 19 and 20 and across the face of the land portion 21. The bridge elements 17 and 18 are then deformed to mash the multiple strand cable into contact with the land portion 21. A locking tab 22 is lanced from the material of the carrier strip 11 and bent to a position as best shown in Figure 3. The locking tab serves to mash and confine the multiple strand cable between the bridge 18 and the end of the tab 22. Furthermore, the position of the parts 18 and 22 is such that the cable loop 14 is caused to extend outward at an angle from the carrier strip 11. The staggered or overlapping position of the ends of adjacent loops 14 serves to lend additional stiffness to the cable loops so that they perform efficiently in service.

The cable loops 14 may be secured to the carrier strip

in the course of passing the carrier strip through multiple stage stamping dies, and the cost of attaching the cable loops to the carrier strip is thereby reduced to a minimum. No welding is required for connecting the cable loops to the carrier strip.

In the modified form of our invention shown in Figure 5, the cable ends 15a and 16a of the same loop 14a are clamped in adjacent relationship rather than being spread apart, as described above. Furthermore, each cable loop 14a passes through the loop of the adjacent cable with the result that each loop contributes to the stiffness of the assembly. The manner of securing the cable ends is substantially the same as that previously described.

Figure 6 shows a modified form of our invention which is similar to that shown in Figure 5, except that the loops 14b are separate and do not intertwine with other loops.

The form of our invention shown in Figures 7, 8 and 9 is substantially the same as that shown in Figure 6, except that the bridge elements 18c is substantially flat along its outer surface rather than being indented to separate the cable ends 15c and 16c. Figure 8 shows how the locking tab 22c engages the multiple strand cable to cause the loop 14c to extend outwardly from the carrier strip at an angle.

The form of our invention shown in Figure 10 is substantially the same as that shown in Figures 7, 8 and 9, except that the cable ends are mounted at an angle with respect to the longitudinal axis of the carrier strip 11d. This serves to twist the planes of the respective cable loops 14d so that they do not all lie in the same plane. This feature tends to increase the turbulence in the mud column when the casing is rotated.

In use, the turbulence generator devices are installed on the casing sections by welding the carrier strips to the outer surface of the casing sections. Rough handling of the casing prior to insertion into the well does not seriously damage the connection between the wire loops and the carrier strip because the bridge elements 17 and 18 are capable of withstanding heavy compressive forces and impacts. The casing string is lowered into the well bore and is then rotated to cause the cable loops to create turbulence in the mud column in the annulus, which action materially assists the cement slurry in displacing the mud from the hole so that a cementing operation of optimum quality is achieved.

In the modified form of our invention in Figures 11-13 the carrier strip comprises a hinged collar 30 having two substantially identical halves 31 and 32. Hinges 33 serve to connect the collar halves as well as to enable the device to be applied laterally to the casing. The loops 14e are applied to the collar 30 in the same manner as described in connection with Figures 1, 2 and 3 and the series of loops extend longitudinally to the collar 30. Stops 34 may be welded or otherwise attached to the casing to limit the extent of axial movement of the collar 30. The collar is free to turn on the casing as well as to move axially.

In that form of our invention shown in Figures 14 and 15 the hinged collar 35 is constructed in substantially the same manner as described in Figures 11-13 and is free to turn on the casing as well as to move axially between the stops 36. The loops of flexible multiple strand cable 14f are mounted on the outer surface of collar halves and the loops extend circumferentially rather than longitudinally. The cable loops are mounted and attached in a manner similar to that described in connection with Figures 1, 2 and 3.

The modifications of our invention shown in Figs. 11 through 15 create turbulence by reciprocating the casing string a distance greater than the clearance between the end of the device and the stops 34 or 36.

It should be observed that although the cable loops are intended primarily to create turbulence, they also necessarily function to scrape the side walls of the bore and loosen at least a portion of the mud therefrom.

This application is a continuation-in-part of our co-pending application, Serial No. 548,933, filed November 25, 1955, now abandoned.

Having fully described our invention, it is to be understood that we do not wish to be limited to the details herein set forth but our invention is of the full scope of the appended claims.

We claim:

1. In a device of the class described, adapted to be mounted on the outer surface of a well pipe, the combination of: a carrier strip, a longitudinal series of turbulence generator elements mounted on said carrier strip, each of said elements including a length of multiple strand wire cable forming a loop and having both ends of the cable length mounted on the carrier strip, the cable ends of each loop being spaced longitudinally along the carrier strip, and in overlapping relation, with the lower cable end of one loop positioned below the upper cable end of the next lower loop, and means for anchoring both ends of each cable to the carrier strip.

2. In a device of the class described, adapted to be mounted on the outer surface of a well pipe, the combination of: a carrier strip, a longitudinal series of elements mounted on said carrier strip, each of said elements including a length of multiple strand wire cable forming a loop and having both ends of the cable length mounted on the carrier strip, the cable ends of each loop being spaced longitudinally along the carrier strip, each cable length passing through the loop formed by an adjacent cable length, and means for anchoring both ends of each cable to the carrier strip.

3. In a device of the class described, adapted to be mounted on the outer surface of a well pipe, the combination of: a carrier strip, a longitudinal series of elements mounted on said carrier strip, each of said elements including a length of multiple strand wire cable forming a loop and having both ends of the cable length mounted on the carrier strip, and a series of clamping means formed integrally with the carrier strip for anchoring all of the cable ends to the carrier strip.

4. The combination set forth in claim 3 in which the cable ends are mounted at an angle on the carrier strip.

5. In a device of the class described, adapted to be mounted on the outer surface of a well pipe, the combination of: a carrier strip, a series of elements mounted on said carrier strip, each of said elements including a length of multiple strand wire cable forming a loop, and means for anchoring the cable ends to the carrier strip including at least one bridge element formed integrally with the carrier strip and projecting outwardly from the outer surface to define an opening receiving the cable ends, said bridge element being compressed around said cable ends to clamp the same to said carrier strip.

6. In a device of the class described, adapted to be mounted on the outer surface of a well pipe, the combination of: a carrier strip, a series of elements mounted on said carrier strip, each of said elements including a length of multiple strand wire cable forming a loop, means for anchoring the cable ends to the carrier strip including a pair of laterally spaced bridge elements formed integrally with the carrier strip and projecting outwardly from the outer surface to define openings receiving the cable ends, and a locking tab formed integrally with the carrier strip and having a portion thereof serving to clamp the cable against a side edge of one of said bridge elements, the locking tab being positioned relative to said bridge element so as to bend the cable loop with relation to the cable ends so that the parts forming the loop extend at an angle from the carrier strip.

7. The combination defined in claim 6 in which the bridge element adjacent the locking tab is centrally indented to clamp the cable ends individually.

8. A well tool for generating turbulence in a mobile mixture flowing in the annular space between a pipe string and a surrounding wall, said well tool comprising: a carrier structure mounted on a section of said pipe string; a

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plurality of substantially nonstretchable, relatively short lengths of multiple strand wire cable; a plurality of securing devices joining each end of each cable length to said carrier structure to form each length into a loop, a first bridge element overlying the adjacent tip end of said cable length at one side of said land, a second bridge element overlying said cable length at the opposite side of said land to anchor said end of the cable length, and a locking tab extending outwardly from said carrier structure in confronting relation with said second bridge element and positioned to engage and bend said cable length adjacent said end, whereby the securing devices at opposite ends of said cable length force the loop portions of said cable lengths between said ends to project outwardly from said pipe string for yieldable and slidable engagement with the surrounding wall, said loop portions tending to create a turbulent flow of a mobile mixture flowing around said loop portions in the space between said pipe string and said wall.

9. A well tool for generating turbulence in a mobile mixture flowing in the annular space between a pipe string and a surrounding wall, said well tool comprising: a carrier structure mounted on a section of said pipe string; a

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plurality of substantially nonstretchable, relatively short lengths of multiple strand wire cable; a plurality of spaced securing devices, each securing device rigidly securing a pair of cable length ends to said carrier structure in contiguous, substantially parallel relation, whereby said cable lengths form loop portions between their secured ends, each securing device including means bearing laterally against said cable ends to cause said cable loop portions to project outwardly from said pipe string for yieldable and slidable engagement with the surrounding wall, said loop portions tending to create a turbulent flow of a mobile mixture flowing around said loop portions in the space between said pipe string and said wall.

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