United States Patent [19]

Schmidt

[11] **3,802,500**

[45] **Apr. 9, 1974**

[54] **GRAVEL PACKING TOOL AND REMOVABLE FLUID DIVERTING BAFFLES THEREFOR**

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[73] Assignee: **Union Oil Company of California**, Los Angeles, Calif.

[22] Filed: **Mar. 23, 1973**

[21] Appl. No.: **344,347**

[52] **U.S. Cl.** **166/51**, 166/173

[51] **Int. Cl.** **E21b 43/04**

[58] **Field of Search** 166/51, 173, 202, 177

[56] **References Cited**

UNITED STATES PATENTS

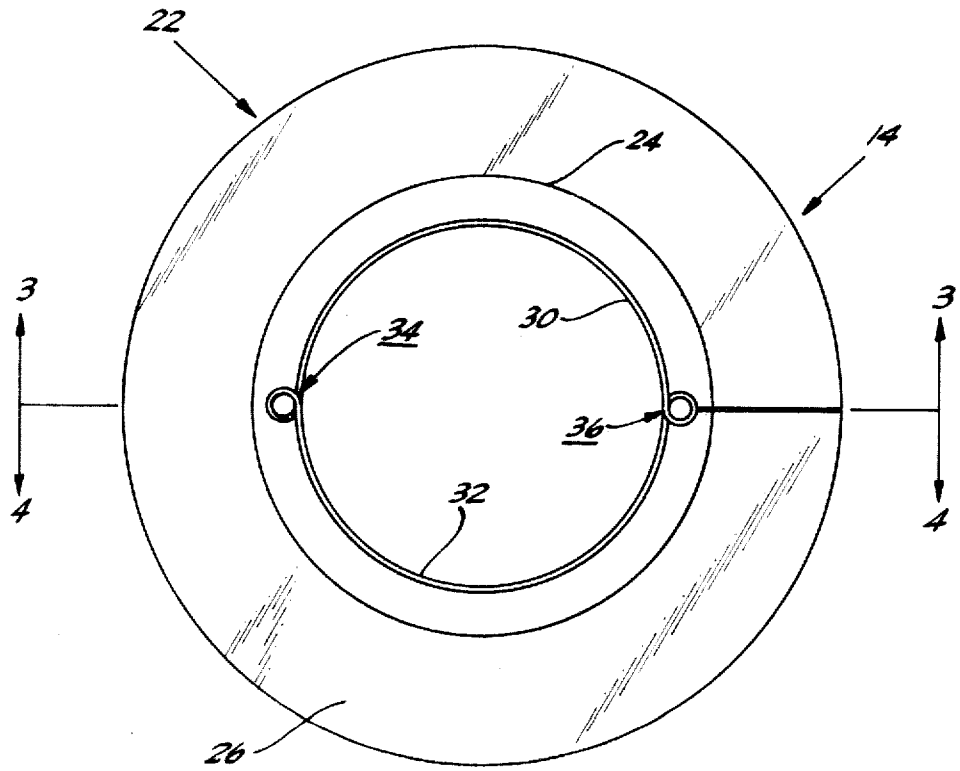
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Primary Examiner—David H. Brown

[57] **ABSTRACT**

A gravel packing tool comprised of a tubular member having at least one removable fluid-diverting baffle slidably mounted thereon. The fluid-diverting baffles consist of a pair of rigid half-sleeves that when placed in abutting relationship made to form a cylindrical sleeve. The half-sleeves are hinged at one abutting edge and provided with a latch to lock them in a cylindrical or closed configuration. An outer resilient member consisting of a hub portion adapted to fit around the cylindrical sleeve and an integral, flexible annular flange extending outwardly from the hub portion is bonded to the sleeve. The hub and flange are split adjacent to the latch so that the fluid-diverting baffle can be opened sufficiently to be placed around the tubular member and latched thereon. Retaining means are provided to limit the longitudinal movement of the fluid-diverting baffles on the tubular member.

19 Claims, 4 Drawing Figures



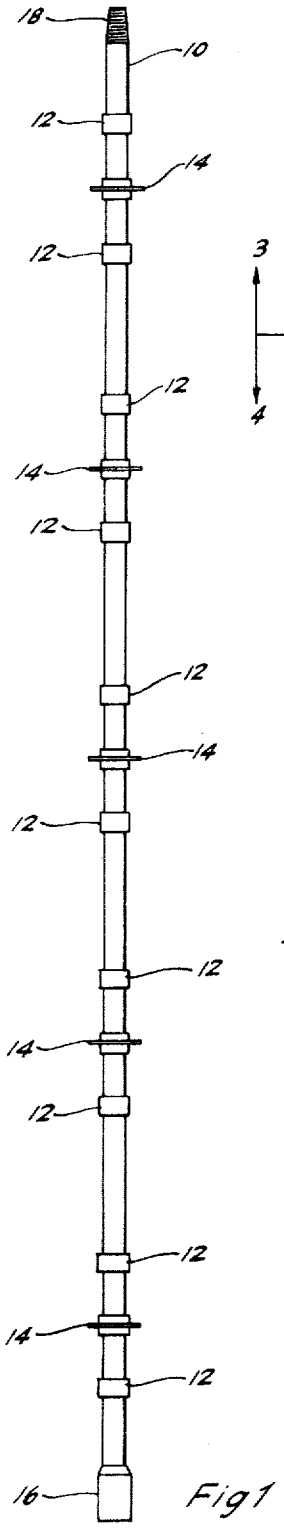


Fig 1

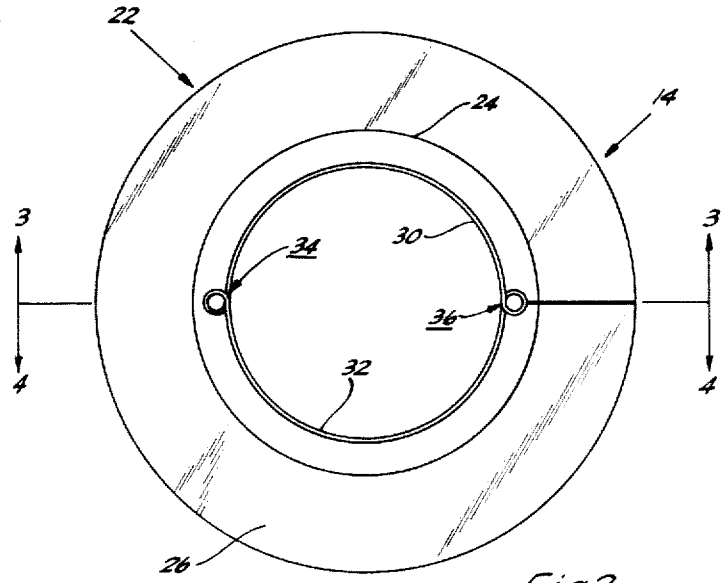


Fig 2

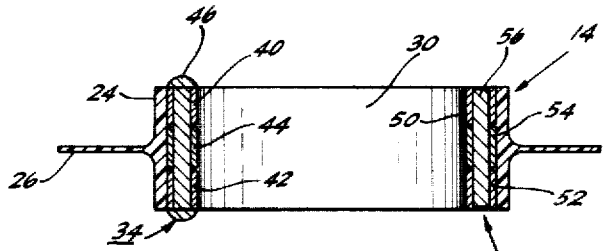


Fig 3

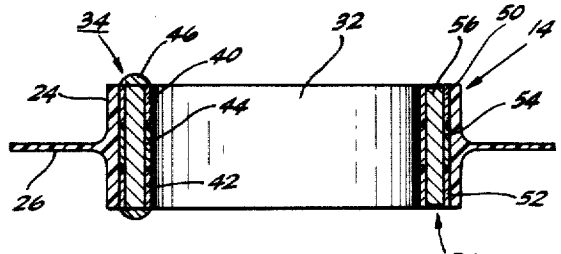


Fig 4

GRAVEL PACKING TOOL AND REMOVABLE FLUID DIVERTING BAFFLES THEREFOR

This invention relates to the completion of wells in subterranean formations, and more particularly to apparatus for gravel packing the annulus surrounding a perforate liner installed in a well.

Recoverable fluids such as petroleum oil, gas and water are frequently found in subterranean formations comprised of unconsolidated or loosely consolidated sand and sandstone. Also, some otherwise consolidated formations become incompetent when certain fluids are produced from or injected into the formation. When such incompetent formations are penetrated by a well and the connate fluids therein removed, the loosely or weakly bound sand particles become dislodged and are entrained in the fluid. The dislodged sand is moved into flow channels causing plugging and a reduction in permeability of the formation. Further, sand can accumulate in the well causing plugging, and can be carried to the surface with the withdrawn fluid. These entrained particles cause severe erosion of underground strainers and liners, the production string, pressure control valves, pumps and flow lines. Oil produced from incompetent formations often requires special treatment to remove entrained sand, and substantial quantities of entrained sand can be deposited in production tanks causing cleaning and disposal problems. In extreme cases, sufficient sand can be removed from the producing formation to cause it to collapse under the overburden pressure resulting in loss of the well. Similar problems are encountered in the injection of water, gas and other fluids into unconsolidated or loosely consolidated formations, or in the formations which become incompetent upon injection of the fluid.

One conventional technique for completing a well in an incompetent formation so as to substantially prevent entrainment of earth particles into the well involves placing a perforate liner in the well at the lower end of a casing string, and to thereafter pack gravel of selected size around the exterior of the liner in the annular space between the liner and the formation wall. The gravel can be hydraulically placed in the well annulus by circulating a suspension of the gravel in water or other liquid through the annulus so that the gravel is deposited therein. It is conventional practice to run the liner into the well on a special gravel packing tool suspended on a running-in string. The gravel packing tool provides a flow crossover from the running-in string to the annulus through gravel ports in a port collar. The tool is suitably packed off above and below the gravel ports. A stinger pipe extends downwardly from the gravel packing tool to a point just above the lower end of the liner and communicates at its upper end through a bypass passage in the tool with an outlet port at the upper end of the tool opening into the annular space between the running-in string and the well casing. The gravel suspension is pumped down the running-in string and through the tool into the port collar and then outwardly through the ports in the latter into the annulus between the formation wall and the upper end of the perforated liner, whereupon the suspension flows downwardly on the exterior of the liner. The liquid in the well displaced by the inflowing suspension and the water or other gravel carrier liquid flows inwardly through the perforations in the liner and into the lower

end of the stinger pipe causing an upward flow through the stinger pipe which escapes through the bypass in the gravel packing tool into the annulus surrounding the running-in string above the packers. This liquid is then returned to the surface through the annulus.

Ideally, the suspension thus pumped into the upper end of the space between the liner and the formation wall will gradually move downwardly displacing the liquid already in this space inwardly through the perforations in the liner. As the suspension reaches the bottom of the annulus, the carrier liquid also passes inwardly through the perforations in the liner, progressively leaving the gravel compactly packed in the annulus on the exterior of the liner, from the bottom of the well upward, until no more gravel suspension can be pumped into the upper end of the annulus. Unfortunately, this process often does not operate as desired, even in substantially vertical wells, resulting in the well annulus surrounding the perforate liner being only partially filled with gravel. One of the theories for such failure is that bridging of the gravel between the liner and the formation wall occurs at a point located a substantial distance above the top of the gravel bed, thus blocking further downward flow of the gravel suspension. After such a bridge occurs, the liquid in the suspension delivered into the annulus above the bridge escapes inwardly through the perforate liner and the annulus is progressively packed with gravel from the bridge upward, but leaving a void in the annulus below the bridge. In practice, a number of such bridges may occur in long liners, leaving a like number of voids in the annulus.

Another problem encountered in the gravel packing of wells is size segregation of gravel within the annulus. Since gravity is the primary force causing the gravel to form a uniform pack, the larger, more dense particles settle faster, thus causing particle size segregation in the gravel pack.

To overcome these problems, it has been proposed that flexible, radial baffles be fixedly mounted at each joint of the stinger pipe, i.e., about each 30 feet, so as to divert the downflowing liquid outwardly into the annulus until a compact gravel pack is formed from the bottom of the annulus upwardly. These baffles are slightly larger than the interior of the liner so that they are theoretically cupped upwardly as the stinger pipe is inserted into the previously placed perforated liner, thus providing a liquid seal against the inner surface of the liner. As the annulus is progressively filled with gravel, the carrier liquid is diverted through the perforations in the liner at progressively higher elevations. When the level of gravel in the annulus builds up past a baffle, the differential pressure across the baffle is increased causing it to be cupped downwardly, thus allowing liquid to flow downwardly past the baffle with relatively little pressure drop.

However, while this embodiment of gravel packing apparatus has been used with some success, it is not universally effective in establishing uniform compact gravel packs, and the use of this tool introduces other problems. Specifically, in the operation of placing the gravel packing tool in the well it is often necessary that the tool be moved up and down in the well short distances and rotated to perform various operations, such as locating the dogs on the tool that permit opening of the gravel ports. The baffles, particularly with long stinger pipes, introduce sufficient friction that it is diffi-

cult to properly perform these necessary operations. Also, as the tool string is moved downwardly and then upwardly in positioning the dogs, the baffles become cupped downwardly and are thus not effective in preventing liquid flow downwardly through the interior of the liner. Further, it is generally found that wells inclined at angles of 45° or more from the vertical cannot be successfully gravel packed, even with the use of the aforementioned gravel packing tool.

U. S. Pat. No. 3,637,010 issued to George P. Maly and Joel P. Robinson on Jan. 25, 1972, discloses an improved gravel packing tool comprised of a number of tubular members that can be axially assembled to form a stinger pipe that it attached to a conventional gravel packing tool and placed in the interior of the perforate liner during the gravel packing operation. A plurality of flexible, radial flow-control baffles are slidably mounted on the tubular member so that the assembled tool is actually movable within the liner, within a limited travel, and rotatable independent of the baffles. Although this tool has been found to be highly successful in placing gravel in the wellbore, particularly in thick pay zones and in wells inclined at angles of 45° or more from the vertical, certain problems have been encountered in the use of the tool. Since the tool may often be as much as 1000 feet, or more, in length, it is broken down into convenient sections about 30 feet long for storage and transport to the jobsite. Thus, each length of tool typically has four to six baffles installed thereon. However, if it becomes necessary to replace baffles, the tool must be broken at each joint to remove the baffle and place the new unit on the tool joint. Also, it is sometimes desirable to remove all of the baffles for storage or transport, which requires breaking each tool joint to remove the baffles and then reassembling the unit at the new jobsite. The replacement of baffles and reassembly of the tool requires substantial time and labor.

Accordingly, a primary object of the present invention is to provide apparatus that permits a compact, uniform bed of gravel to be hydraulically placed around the exterior of a perforate liner, and which can be conveniently and expeditiously assembled, used and disassembled. Another object of the invention is to provide a gravel packing tool having a baffled stinger pipe that can be readily positioned in the proper vertical location in the well, and wherein the baffles can be individually installed upon, and removed from the tool without disassembly of the tool. A further object of the invention is to provide a gravel packing tool having a baffled stinger pipe that can be moved up and down axially in the well over a limited distance and rotated without affecting the seating of the baffles within the liner, and which has baffles that can be individually installed upon and removed from the stinger pipe without disassembly of the tool. A still further object of the invention is to provide a tool for gravel packing wells inclined from the vertical, and particularly for gravel packing wells inclined at angles in excess of 45° from the vertical, which has fluid-diverting baffles that can be individually placed upon and removed from the tool without disassembly of the tool joint. Still another object of the invention is to provide a fluid-diverting baffle that can be mounted upon a tubular member without disassembly of the tool.

The manner of accomplishing the foregoing objects as well as further objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings, wherein like numerals refer to corresponding parts, and in which:

FIG. **1** is a side view of the assembled gravel packing tool of this invention;

FIG. **2** is a top view of the fluid-diverting baffle of this invention;

FIG. **3** is a sectional view of this diverting baffle taken along the line **3—3** of FIG. **2**; and

FIG. **4** is a sectional view of the diverting baffle illustrated in FIG. **2** taken along the line **4—4** of FIG. **2.**

Referring specifically to the drawings, FIG. **1** shows the assembled tool consisting of tubular member **10** having a number of pairs of retainers **12** at longitudinally spaced intervals along the member **10** and a plurality of fluid-diverting baffles **14** mounted thereon, one of the fluid-diverting baffles being installed between each pair of retainers **12.** Preferably, fluid-diverting baffles **14** are mounted on tubular member **10** so that the baffles slide longitudinally on the tubular member between adjacent retainers **12** and are rotatable on the tubular member. Thus, in the preferred embodiment, the member **10** can be moved up or down a limited distance in the well, and rotated, independently of the fluid-diverting baffles. This feature permits manipulation of the tubing string without disturbing the baffle position, and also avoids the substantial friction encountered in attempting to manipulate a tubing string provided with a large number of fixed fluid-diverting baffles.

Tubing member **10** can be any elongated tubular member capable of being inserted into a well, such as a tubing joint conventionally employed for the production of oil and gas, exemplary of which are API nonupset tubing and API external-upset tubing that have male pin threads at both ends and are joined by appropriately threaded couplings; and Extreme-line. Spangseal and flush or externally upset Hydril-type tubing that have a female threaded box, such as box **16,** at one end and a male threaded pin, such as pin **18,** at the other end. Tubing is conventionally fabricated in 30 foot lengths, and the individual tubing joints can be threaded together to form tubular members of any desired lengths.

Retainers **12** are provided to limit the longitudinal movement of fluid-diverting baffles **14** on tubular member **10** so as to maintain proper baffle spacing, a retainer being located on either side of each fluid-diverting baffle. Any suitable type of retainer can be employed. For example, the retainers can be metal dogs permanently attached to tubing member **10** by welding or other means so as to protrude outwardly from the surface of the tubular member thereby restricting the longitudinal movement of the fluid diverting baffles, or circumferential rings fixed to or integrally formed with the member **10.** However, it is preferred that the retainers be of the type that can be mounted on tubing member **10** and conveniently removed or relocated as circumstances may warrant. Suitable clamp-on stop devices of the split ring type that can be opened for insertion around the tubular member and then immovably clamped thereon by means of a releasable latch mechanism are commercially available. One suitable line of friction lock clamps is marketed by B and W, Incorporated of Torrance, California. However, retainers **12** can be any de-

vice formed integrally with or attached to the tubing to limit the longitudinal displacement of the fluid-diverting baffles.

As illustrated in FIGS. **2, 3** and **4,** fluid-diverting baffles **14** are comprised of a rigid cylindrical sleeve **20** having a uniform, close-tolerance inside diameter slightly larger than the outside diameter of tubular member **10,** and an integral molded outer member **22** consisting of a central hub portion **24** adapted to fit around sleeve **20** and a substantially flat, flexible annular flange portion **26** extending radially from the hub portion. The inner surface of hub portion **24** is bonded to the outer surface of cylindrical sleeve **20** to provide a unitary structure. Outer member **22** is formed of resilient material, and is preferably formed of rubber exhibiting a Shore hardness of about 40 to 90 on the A scale, although other resilient rubber and plastic materials exhibiting similar properties can be employed. The outer diameter of flange **26** is preferably selected so that it is slightly larger than the inside diameter of the perforated liner in which the baffles are to be employed. In this manner, the baffles will be cupped upwardly on insertion into the liner, thus acting as a seal against downflowing liquid, and will be forced into a downwardly cupped configuration as the differential pressure increases, thus allowing fluid to flow downwardly around the baffles without excessive restriction.

Sleeve **20** is comprised of two half-sleeves **30** and **32** pivotally connected by means of a hinge **34** that allows the device to be opened for placement around tubular member **10,** and a latch **36** located diametrically opposite hinge **34** to lock sleeve **20** in a cylindrical or closed configuration. Molded member **22** is split radially adjacent to latch **36** to facilitate opening of the device. In this manner, the fluid diverting baffles can be opened sufficiently for placement at specified locations on the tubular member between adjacent retainers and latched to lock the sleeve **20** in a cylindrical configuration whereby the fluid-diverting baffle is maintained slidably mounted on the tubular member.

In the illustrated embodiment, half-sleeve **30** includes integrally formed hinge eyes **40** and **42** located in axially aligned spaced relationship at one abutting edge of the sleeve and half-sleeve **32** includes a single integrally formed hinge eye **44** at one abutting edge of half-sleeve **32** so as to be axially aligned with and between hinge eyes **40** and **42.** Hinge pin **46** is inserted through hinge eyes **40, 44** and **42** to pivotally attach half-sleeves **30** and **32.** Similarly, half-sleeve **32** includes integrally formed latch eyes **50** and **52** located in axially aligned, spaced relationship at the other abutting edge of the sleeve and half-sleeve **30** includes a single integrally formed latch eye **54** at its other abutting edge so as to be axially aligned with and between latch eyes **50** and **52** when the half-sleeves are in the closed or cylindrical configuration. Latch pin **56** is removable inserted through latch eyes **50, 54** and **52** to lock sleeve **20** in a cylindrical configuration. The fluid diverting baffle can be latched in a closed or cylindrical configuration by merely aligning the latch eyes and inserting latch pin **56** therethrough. The fluid-diverting baffle can then be removed from tubular member **10** by removing latch pin **56,** opening sleeve **20** and removing it from member **10.** The molded outer member **22** has sufficient resilience that the sleeve can be opened wide enough to pass around member **10,** i.e., the sleeve can be opened at least as wide as its inside diameter.

To assure that fluid-diverting baffles **14** will freely move longitudinally and rotatably on the member **10,** it is preferred that the smoothness of the exterior surface of the member **10** and the fit of sleeve **20** on the member **10** be maintained within prescribed tolerances. Preferably, the exterior surface of tubular member **10** is machined or ground to an ASA smoothness of 125 or less, and the member **10** has a substantially uniform diameter within a tolerance of +0 and −0.005 inches of the nominal diameter. The inside diameter of cylindrical sleeve **20,** when in a cylindrican configuration, has a substantially uniform inside diameter about 0.010 to 0.015 inches larger than the nominal outside diameter of tubular member **10.** Maintenance of the diameters within these tolerances provides a clearance between tubular member **10** and sleeve **20** of 0.010 to 0.020 inches. Exemplary dimensions for standard API tubing are illustrated in Table 1.

TABLE 1

Nominal Outside Diameter inches	Actual Outside Diameter of Tubular Member, Inches Maximum	Minimum	Actual Inside Diameter of Cylindrical Sleeve, inches Maximum	Minimum
2 1/16	2.063	2.058	2.078	2.073
2⅜	2.375	2.370	2.390	2.385
2⅞	2.875	2.870	2.890	2.885
3½	3.500	3.495	3.515	3.510
4	4.000	3.995	4.015	4.010
4½	4.500	4.495	4.515	4.510

It has been found that the spacing between the baffles is critical, since at too great of a spacing the carrier liquid will pass into the liner prematurely, which promotes bridging in the annulus and prevents the formation of satisfactory gravel packs, and excessive pressure drop may occur at too close spacing. The maximum distance between baffles **14** required for satisfactory operation is dependent in part upon the size of the liner perforations, the densities of the gravel and the carrier liquid, the viscosity of the carrier liquid, the gravel size, and the injection rate. However, in most applications it has been found that the baffles should not be placed more than about 10 feet apart, and are more preferably placed between about 5 and 8 feet apart. The spacing between adjacent baffles is determined by the spacing of adjacent pairs of retainers **12.** Thus, the retainers are placed on tubular member **10** to provide the desired spacing. The individual retainers of each pair of retainers **12** are placed about ¾ to 3 feet apart, and more preferably from about ¾ to 1½ feet apart so as to limit the longitudinal movement of fluid-diverting baffles **14** to this distance. Moreover, while the fluid-diverting baffles are illustrated as being installed individually on tubular member **10,** i.e., one fluid-diverting baffle is mounted between each pair of retainers **12,** in some instances it may be preferred to install a plurality of the baffles, such as from about two to five baffles, between retainers **14.** Also, at closer baffle spacings, one of the retainers between adjacent baffles can be deleted.

The gravel packing tool of the present invention is employed in conjunction with a conventional crossover tool and packer assembly such as described in U.S. Pat. No. 3,637,010, the disclosure of which is incorporated herein by reference. The tool of this invention replaces the stinger pipe and baffle assembly disclosed in the prior patent.

Although the gravel packing tool of this invention is conventionally employed in standard 30 foot lengths,

the length of the individual tubing joint is not critical, and tubular member **10** can be of any convenient length. A number of the tubular members are connected to provide a tool of the desired length, such as a length of up to 1,000 feet or more.

Various embodiments and modifications of this invention have been described in the foregoing description and drawings, and further modifications will be apparent to those skilled in the art. Such modifications are included within the scope of this invention as defined by the following claims.

Having now described my invention, I claim:

1. A fluid-diverting baffle for removable mounting on a tubular member, which comprises:

a rigid cylindrical sleeve having a longitudinal hinge means to allow said sleeve to be opened at least as wide as the diameter of said sleeve, said sleeve being longitudinally split at a point diametrically opposite said hinge means, and said sleeve having a latching means to lock said sleeve in a cylindrical configuration; and

an outer member of a resilient material having a hub portion adapted to fit around said cylindrical sleeve and an integral flexible annular flange extending outwardly from the hub portion, said hub portion being bonded to said cylindrical sleeve so as to provide a unitary structure, and said hub portion and flange being split adjacent to said latch means;

whereby said fluid-diverting baffle can be opened sufficiently to be placed around a tubular member and removably mounted thereon.

2. The device defined in claim **1** including, in combination, (1) a tubular member; (2) a pair of retaining means in longitudinally spaced relationship on said tubular member; and (3) at least one of said removable fluid-diverting baffles slidably mounted on said tubular member so as to slide thereon between said retaining means.

3. A fluid-diverting baffle for removable mounting on a tubular member, which comprises:

a pair of rigid half-sleeves that when placed in abutting relationship mate to form a cylindrical sleeve;

hinge means attached at one of the abutting edges of each of said half-sleeves to pivotally join said half-sleeves along one abutting edge thereof;

latch means to releasably latch said half-sleeves in a cylindrical configuration; and

an outer member molded of a resilient material and having a hub portion adapted to fit around said cylindrical sleeve and an integral flexible annular flange extending outwardly from the hub portion, said hub portion being bonded to said cylindrical sleeve so as to provide a unitary structure, and said hub portion and flange being split adjacent to said latch means;

whereby said fluid-diverting baffle can be opened sufficiently to be placed around a tubular member and removably mounted thereon.

4. The device defined in claim **3** wherein said flexible annular flange is a substantially flat member extending radially from said hub.

5. The device defined in claim **3** wherein said resilient material is rubber.

6. The device defined in claim **5** wherein said rubber has a Shore hardness of 40 to 90 on the A scale.

7. The device defined in claim **3** wherein said latch means is attached at the abutting edges of each of said half-sleeve diametrically opposite said hinge means.

8. The device defined in claim **7** wherein said hinge means comprises a pair of spaced apart, axially aligned, hinge eyes on a first half-sleeve; a hinge eye on said second half-sleeve that is axially aligned with and between the hinge eyes of said first half-sleeve; and a hinge pin inserted through said hinge eyes.

9. The device defined in claim **8** wherein said hinge eyes on each of said half-sleeves are formed integrally with said half-sleeves.

10. The device defined in claim **8** wherein said latch means comprises a pair of spaced apart, axially aligned, latch eyes on said second half-sleeve; a latch eye on said first half-sleeve that is axially aligned with and between the latch eyes of said second half-sleeve when said half-sleeves are in a cylindrical configuration; and a pin removably insertable through said latch eyes.

11. The device defined in claim **10** wherein said latch eyes on each of said half-sleeves are formed integrally with said half-sleeves.

12. The device defined in claim **3** including, in combination, (1) a tubular member; (2) a pair of removable retaining means mounted in longitudinally spaced relationship on said tubular member; and (3) at least one of said removable fluid diverting baffles slidably mounted on said tubular member so as to slide thereon between said retaining means.

13. The device defined in claim **12** wherein said retaining means are positioned on said tubular member about ¾ to 3 feet apart.

14. The device defined in claim **12** wherein said tubular member has a smooth outer surface of ASA **125** or less smoothness and a uniform outside diameter having a tolerance of +0 and −0.005 inches of the nominal diameter, and wherein the inside diameter of said cylindrical sleeve is 0.010 to 0.015 inches larger than the nominal diameter of said tubular member.

15. The device defined in claim **12** wherein a plurality of fluid diverting baffles are located in spaced relationship on said tubular member.

16. The device defined in claim **15** wherein said fluid diverting baffles are spaced about 2 to 10 feet apart on said tubular member.

17. A fluid-diverting baffle for removable mounting on a tubular member, which comprises:

a first rigid, semi-circular, half-sleeve having a pair of integrally formed, spaced apart, axially aligned hinge eyes at one abutting edge and an integrally formed latch eye at the abutting edge of said half-sleeve diametrically opposite said hinge eyes;

a second rigid semi-circular half-sleeve that when placed in abutting relationship with said first half-sleeve forms a cylindrical sleeve, said second half-sleeve having an integrally formed hinge eye at one abutting edge that is axially aligned with and between the eyes of said first half-sleeve and a pair of integrally formed latch eyes at the abutting edge of said half-sleeve diametrically opposite said hinge eye that are axially aligned with the latch eye of said first half-sleeve when said half-sleeves are in a cylindrical configuration;

a hinge pin inserted through the hinge eyes of said first and second half-sleeves to pivotally join said half-sleeves along one abutting edge thereof;

a latch pin removably insertable through the latch eyes of said first and second half-sleeves to releasably latch said half-sleeves in a cylindrical configuration;

an outer member molded of rubber having a Shore hardness of 40 to 90 on the A scale, said member having a hub portion adapted to fit around said cylindrical sleeve and an integral flexible annular flange extending radially outward from the hub portion, said hub portion being bonded to said cylindrical sleeve so as to provide a unitary structure, and said hub portion and flange being split adjacent to said latch means;

whereby said fluid diverting baffle can be opened sufficiently to be placed around a tubular member and removably mounted thereon.

18. The device defined in claim **17** including, in combination, (1) a tubular member having a substantially uniform outside diameter; (2) a plurality of pairs of retaining means on said tubular member, the retaining means of each pair being located about ¾ to 3 feet apart and said pairs of retaining means being located about 22 to 10 feet apart; and (3) at least one of said fluid diverting baffles being slidably mounted on said tubular member between the retaining means of each of a plurality of said pairs of retaining means so as to slide on said tubular member between said retaining means.

19. The device defined in claim **17** including, in combination, (1) a tubular member having a smooth outer surface of ASA 125 or less smoothness and a uniform outside diameter having a tolerance of +0 and −0.005 inches of the nominal diameter; (2) a plurality of pairs of removable retaining means mounted on said tubular member, the removable retaining means of each pair being located about ¾ to 1½ feet apart and said pairs of removable retaining means being located about 5 to 8 feet apart; (3) at least one of said removable fluid diverting baffles being slidably mounted on said tubular member between the removable retaining means of each of a plurality of said retaining means so as to slide on said tubular member between said retaining means, said cylindrical sleeve having an inside diameter about 0.010 to 0.15 inches larger than the nominal outside diameter of said tubular member.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,802,500 Dated April 9, 1974

Inventor(s) Ethan R. Schmidt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 18, column 9, line 23 - "22" should be - 2 -.

Line 5 of the Abstract, change "made" to - mate -.

In the drawing, the numeral 20 and lead line should be added to Figure 2 as referred to on page 9, line 2 of the specification.

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
U.S. GOVERNMENT PRINTING OFFICE 1969 O - 366-334