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Gary

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[54] **SYSTEM STABILIZER**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 305,091, Nov. 15, 1972, Pat. No. 3,835,015.

[52] **U.S. Cl.** **204/197;** 204/148; 204/150; 204/248; 204/280; 204/275; 204/286; 204/288; 204/289

[51] **Int. Cl.**[2] **C23F 13/00;** C02B 1/82

[58] **Field of Search** 204/147, 148, 196, 197, 204/149, 150, 248, 280, 286, 288, 289, 275–279; 138/156, 166

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[57] **ABSTRACT**

A fluid stabilizer rod consists of an alloy of copper, zinc, nickel and tin adapted to be installed in a fluid conduit and to have a fluid flowing thereover. The rod is generally elongated and tubular and comprises three elongated, generally planar members positioned to form a generally triangular rod having a generally triangular passageway for the flow of fluids therethrough. A cylindrical casing circumferentially surrounds and supports the rod, the planar members defining with the inner casing walls additional passageways for the flow of fluids therethrough.

25 Claims, 8 Drawing Figures

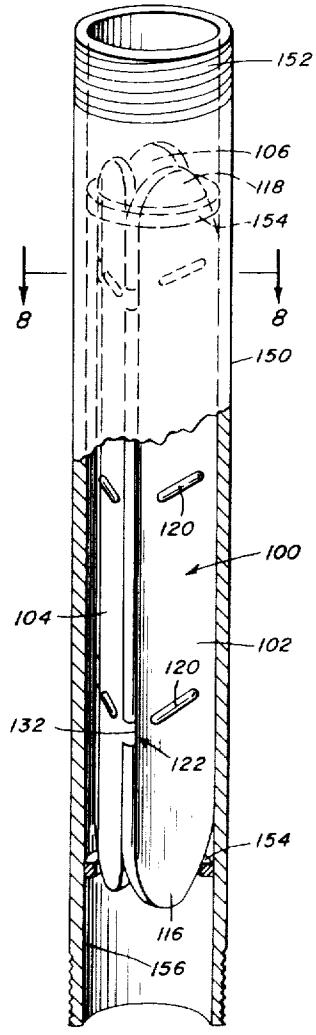


Fig. 1

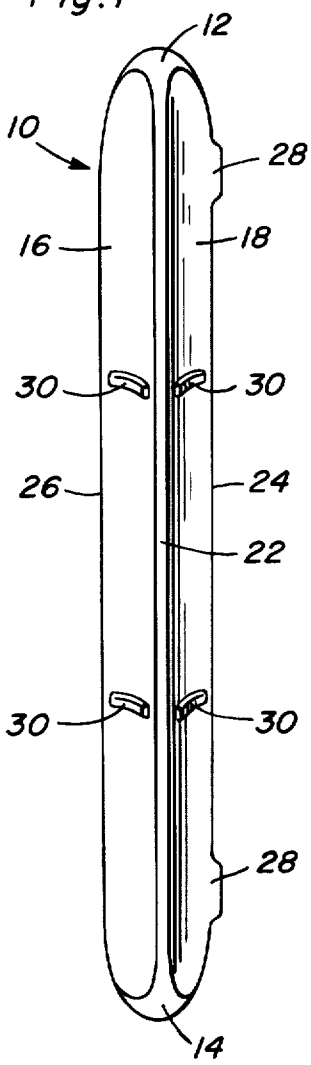


Fig. 2

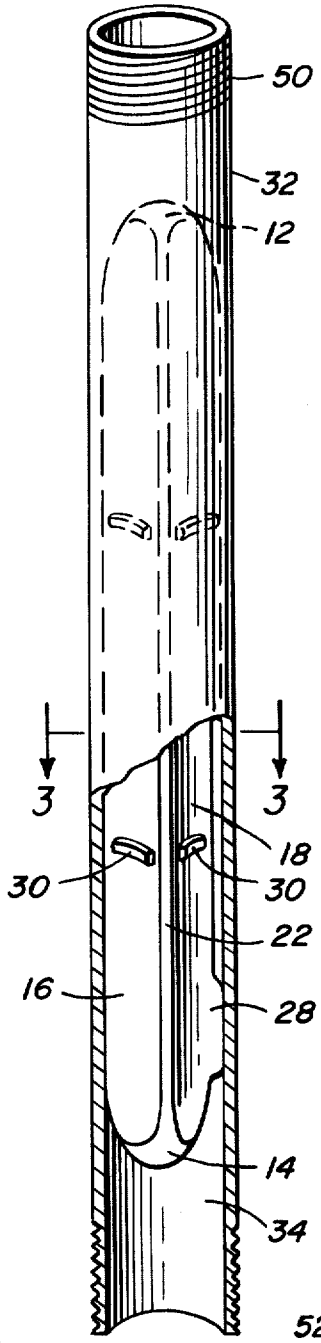


Fig. 4

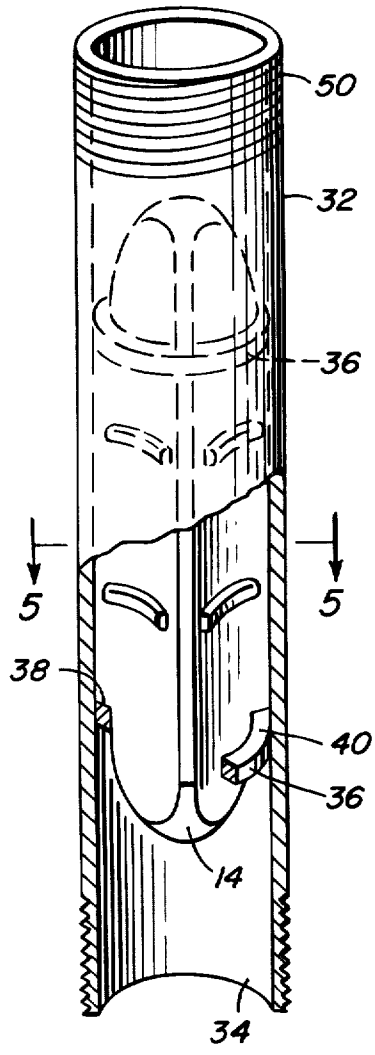


Fig. 3

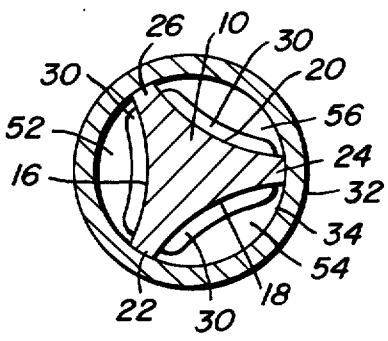


Fig. 5

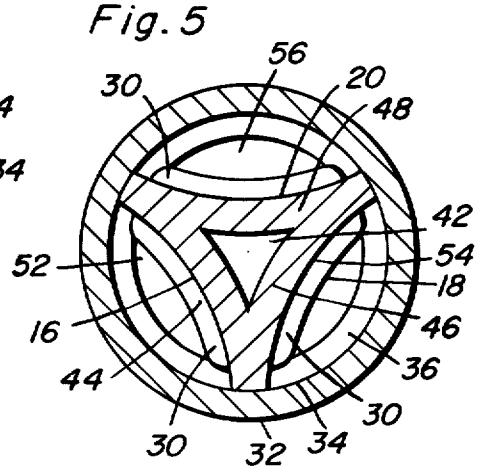


Fig. 6

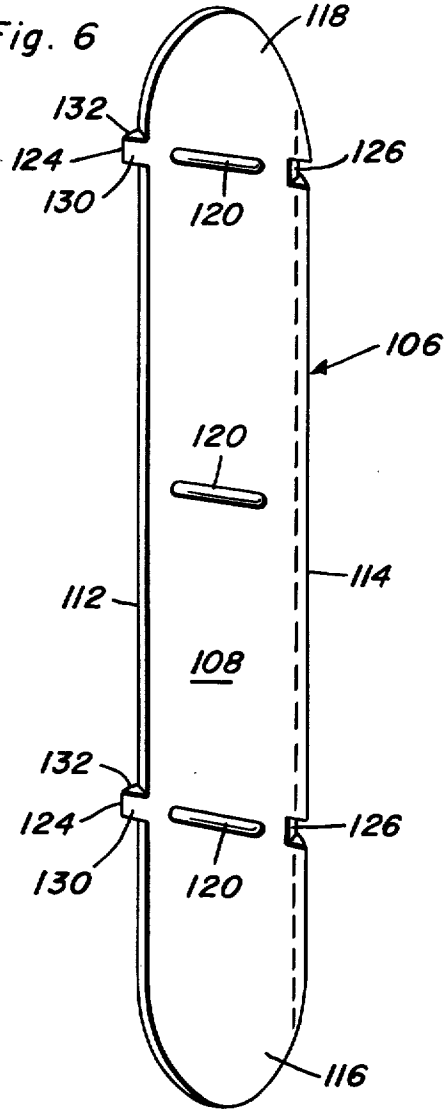


Fig. 7

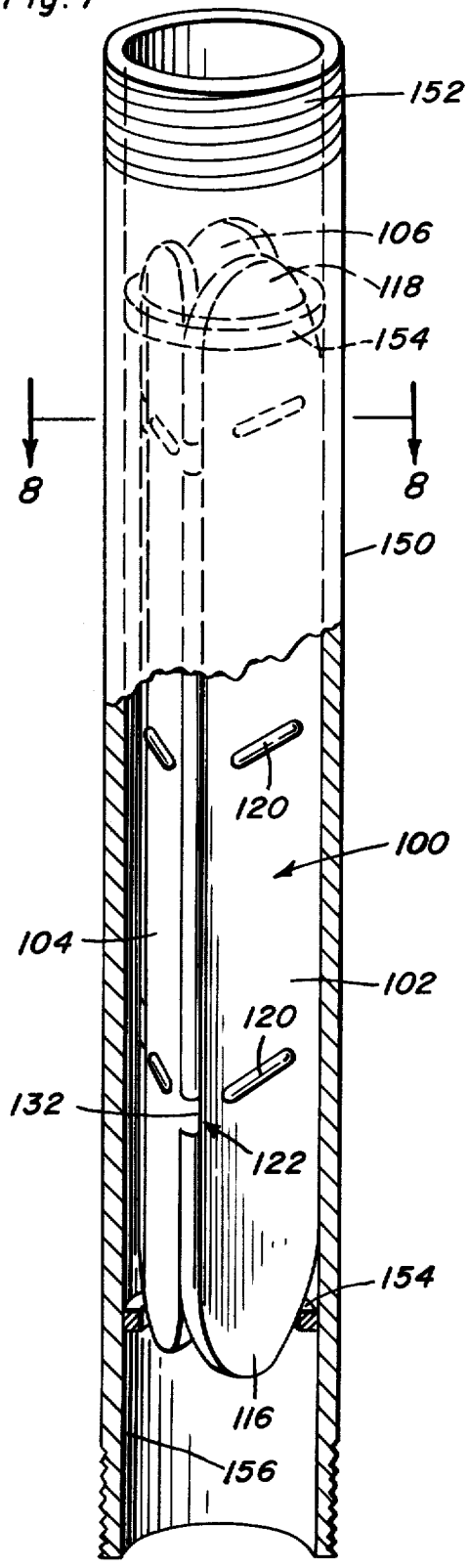
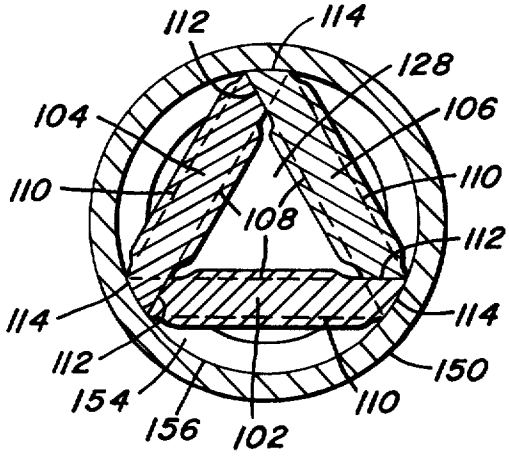


Fig. 8



SYSTEM STABILIZER

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of copending application Ser. No. 305,091, filed Nov. 15, 1972, now U.S. Pat. No. 3,835,015.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to apparatus for controlling scale deposition and, more particularly, to a fluid stabilizing rod having a metallurgical composition and physical configuration specifically adapted to inhibiting scale deposition.

2. Description of the Prior Art

A well known problem associated with oil and water wells in the accumulation of paraffin and scale in, as well as the corrosion of, the flow tubes, pumps and other equipment associated with the well. The problem is particularly acute where the mineral content of the fluids flowing in the well system is high and the deposition of compounds of these minerals is correspondingly high, causing operational, production and economic difficulties. Particularly bothersome are compounds, such as calcium carbonate and/or sulfate, iron oxide and/or sulfide, as well as hydrogen sulfide, free sulfur and sodium salts.

One solution to this problem heretofore suggested is to preclude, to the greatest extent possible, deposition of precipitates of these mineral compounds. If the compounds could be maintained in colloidal or suspension form, then they could not scale or erode tubing walls and equipment surfaces and the problems associated with their presence would be largely ameliorated. U.S. Pat. No. 3,448,034 to Craft teaches that a stabilizing element comprising a metal core housed in a flow tube has a polarizing effect on the fluid in the tube to eliminate any affinity between the mineral compounds and the surfaces of the flow system, thereby preventing precipitation of the compounds. Craft's core is generally oval in cross section and has a composition consisting of 57.64 percent copper, 17.63 percent zinc, 13.45 percent nickel, 7.66 percent lead, 2.69 percent tin and 0.69 percent iron and trace amounts of antimony, sulfur and manganese. U.S. Pat. No. 3,486,999 to Craft, et al., teaches a particular apparatus configuration to accomplish the polarization of the fluid using a primarily copper, zinc, silicon core.

The prior art devices function only to a somewhat limited extent; it having been found that they are largely inefficient in preventing scale formation and corrosion. This inefficiency is in part attributable to the metallurgical composition of the rod, but to a greater extent is attributable to a failure to provide an optimum core configuration in terms of the two key variables of pressure drop (and thus fluid velocity) and surface area.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a fluid stabilizing rod which controls and inhibits its scale deposition by virtue of its metallurgical composition and physical configuration.

It is another object of the invention to provide a fluid stabilizing apparatus which provides a controlled pressure drop thereacross and therefore contributes to controlling fluid velocity as well as fluid chemistry.

It is still another object of this invention to provide apparatus which controls scale deposition by utilizing flow velocity to determine the size and quantity of precipitates formed in the fluid.

Other objects and advantages will become apparent from the following description and appended claims.

Briefly stated, in accordance with the aforesaid objects, the present invention provides an elongated fluid stabilizing rod consisting of an alloy of copper, zinc, nickel and tin adapted to be installed in a fluid conduit and to have a fluid flowing thereover. In one form of the invention the rod is generally triangular in cross section with each side thereof defining a lengthwise extending concave arcuate surface. Fluids flow over and in contact with the arcuate surface. The apices of the triangle contact a cylindrical casing in which the rod is enclosed to permit a force or press fit of the rod therein. Alternatively, the rod may be retained in the casing by washers disposed at each end of the rod and secured to the casing. In another form of the present invention, the rod has a lengthwise extending passageway formed therethrough to increase the surface area of the rod available for fluid contact. In still another embodiment of the invention, the fluid stabilizing rod is tubular in nature consisting of at least three elongated, generally planar side members forming the periphery of the rod and including coacting means constraining the side members against relative longitudinal shifting.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood from the following description taken in conjunction with the accompanying drawings.

FIG. 1 is a perspective view of one embodiment of the fluid stabilizing rod of the present invention.

FIG. 2 is a perspective view of an embodiment of the apparatus of the present invention with portions broken away showing the rod press fit into a cylindrical casing therefor.

FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 2.

FIG. 4 is a perspective view of another embodiment of the apparatus of the present invention with portions broken away showing the rod held in a cylindrical casing by washers secured to the casing.

FIG. 5 is a sectional view taken substantially along the line 5—5 in FIG. 4.

FIG. 6 is a perspective view of one of the side members of a generally triangular, three-member stabilizing rod of the present invention.

FIG. 7 is a perspective view of still another embodiment of the apparatus of the present invention with portions broken away showing a three-member stabilizing rod, including side members as in FIG. 6, held in a cylindrical casing by washers secured to the casing.

FIG. 8 is a sectional view taken substantially along the line 8—8 in FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

The fluid stabilizer rod of the present invention is primarily a device to control scale deposition. It does not prevent scale from forming, but provides an effective method of controlling where it forms. More particularly, the rod permits scale compound precipitates to form in the flowing fluid but, by virtue of its composition and configuration, controls the size of the precipi-

tates and thus their tendency or ability to settle on the flow tube and equipment surfaces.

Referring to FIG. **1**, there is shown generally at **10** one form of the fluid stabilizer rod of the present invention. Rod **10** is generally elongated and is tapered or nosed at each end **12, 14** to provide smooth fluid pressure transitions at the ends. In cross section, rod **10** is generally triangular except that sides or surfaces **16, 18, 20** are inwardly bowed or hollowed to define lengthwise extending, concave arcuate surfaces. The generally triangular cross section includes lengthwise extending apices **22, 24, 26** at the intersections of sides **16** and **18, 18** and **20,** and **20** and **16,** respectively. Apex **24** has lugs **28** thereon to accommodate variations in the inner diameter of casings in which rod **10** is inserted. Lugs **28** extend outwardly from apex **24** along the bisector of the excluded angle of the apex, i.e., the excluded angle formed by the intersection of sides **18** and **20.** Surfaces **16, 18, 20** each include projections **30** thereon extending outwardly from the surfaces and disposed perpendicularly to the longitudinal axis of the rod. As fluid flow proceeds along the longitudinal axis of the rod, over and in contact with surfaces **16, 18** and **20,** projections **30** (two are shown on each surface; however, three or more are preferred on long rods) tend to break up the boundry layer and thereby increase fluid turbulence. Increased turbulence and the attendant increased mixing effect enhances the extent of surface contact between surfaces **16, 18, 20** and the fluid, thereby increasing the effective fluid contact areas of these surfaces.

Rod **10** is preferably installed in a cylindrical casing or flow tube **32,** as shown in FIG. **2,** and retained therein by a friction or press fit between lugs **28** and the inner wall **34** of the tube **32.** As a practical manner, upon force fitting rod **10** in tube **32,** lugs **28** tend to deform with the result that apices **22, 24, 26** are in substantial contact with wall **34.** As shown in FIG. **4,** an alternative means of retaining rod **10** in casing **32** is to provide circumferential washers **36** welded or otherwise secured to the inner wall **34** of the casing near the ends **12, 14** of the rod **10.** When washers **36** are used as the retaining means, rod **10** preferably has a shoulder **38** formed in each apex adjacent nosed ends **12, 14** such that the ends **12, 14** project through washers **36** with shoulders **38** engaging the inwardly facing surfaces **40** of the washers.

In an alternative embodiment, rod **10** may include a longitudinally extending passageway **42** through the center of the rod to provide an additional fluid flow channel. Preferably, passageway **42** has the same cross-sectional configuration as the rod, i.e., generally triangular with the sides thereof defining longitudinally extending, outwardly concave (inwardly convex) arcuate surfaces **44, 46, 48.** These latter surfaces are substantially parallel to corresponding surfaces **16, 18, 20,** respectively, and provide substantially increased surface area for contact with the flowing fluid.

In use, rod **10** is inserted and retained within casing **32** and, in this configuration, is installed in a flow system, such as an oil or water well, a steam boiler, or the like, without need to modify the system. Generally, the diameter of casing **32** corresponds to the diameter of the tubing in the system unless some smaller diameter casing is necessary to assure a minimum flow rate over surfaces **16, 18, 20.** When rod **10** is furnished already inserted within a flow tube, such as casing **32,** the casing may include means, such as external threads **50,** for installing the tube in the system. Alternatively, the tube may be welded or otherwise fluid-tightly inserted and secured into the system. The fluid is caused to flow into one end of the casing **32,** whereupon it divides over nosed end **12** to flow through the three passageways **52, 54, 56** bounded by each of arcuate surfaces **16, 18** and **20** and inner wall **34.** Turbulent flow occurs in each passageway causing mixing therein and extensive contact between the fluid and surfaces **16, 18, 20** whereby polarization of the minerals in the fluid occurs. Enhanced polarization is achieved in accordance with the present invention by virtue of the arcuate nature of the surfaces and the particular configuration of rod **10** to provide maximum surface area for fluid contact. The fluid leaves each of the defined passageways, re-mixes as it flows over nosed end **14** and leaves casing **32.**

Without wishing to be bound to any particular theory of operation, it is believed that the polarizing effect is due to strong electrochemical reactions involving the metals of the rod in a scale forming environment. Due to the composition of the rod, numerous positive and negative poles are developed on its surface when installed in a conductive environment. Charged mineral ions in the fluid are drawn to the poles on the rod and the result is a substantial concentration of a portion of the ions in solution. As the scale forming ions are attached to the metal surface, their concentration increases and scale compounds begin to precipitate. The quantity and size of the precipitates is influenced, however, by the core configuration. By virtue of the cross-sectional configuration of the core, a minimum pressure drop across its length is developed. This pressure drop aids in releasing dissolved acid forming gases, such as carbon dioxide and hydrogen sulfide, causing a slight in situ alteration of the fluid chemistry. This alteration increases scaling tendencies and influences the quantity of precipitates formed. Likewise, due to the pressure drop and the water velocity through the passageways, only sub-microscopic precipitates have time to form before they are swept downstream. The small size of the precipitates provides a desired colloidal dispersion that functions as a surface for further mineral ion precipitation. Thus, the great surface area of these sub-microscopic precipitates creates a colloid effect whereby additional ions precipitate thereon, with the net effect that scale forming precipitates are kept in the fluid and in motion and are unable to settle onto system surfaces. It is believed that this mechanism explains the phenomena often observed by which scale formation is not only prevented but existing scale deposits are diminished or removed. This occurs because scale formation is a dynamic process involving continuous deposition, erosion and re-deposition. Inasmuch as the fluid stabilizing rod of the present invention effectively precludes deposition and re-deposition, erosion becomes the controlling factor and existing scale deposits decrease.

As exemplary embodiments of the fluid stabilizing apparatus, rod **10** has been manufactured in lengths from about 10 to 42 inches and in over-all widths suitable for insertion into cylindrical casings having internal diameters ranging from ⅜ to 14 inches. Generally, length and width (diameter) are correlated with the length increasing with increasing width (diameter). It will be appreciated that as the width (diameter) increases, the rods become quite massive and, notwithstanding their concave outer surfaces, become a sub-

stantial impediment or restriction to flow through the cylindrical casing. Accordingly, a lengthwise extending passageway can be formed in the rod to provide additional flow area and, at the same time, additional surface area. It has been found that maximum rod effectiveness is achieved in an apparatus wherein the rod presents an area restriction to flow through the casing of about 38 to 40 percent, i.e., the percent ratio of flow area through a casing including a rod therein to flow area through an empty casing is in the range 38 to 40 percent. The pressure drop thus created together with a minimum flow velocity of about 3 feet per second over the extensive surface area of the rod of the present invention insures maximum effectiveness in polarizing the fluid.

Another form of fluid stabilizing rod having a flow passageway therethrough is shown in FIGS. **6–8.** Rod **100** consists of three elongated, generally planar members **102, 104** and **106** assembled and interengaged along their respective side edges to form a generally tubular triangular rod having a generally triangular passageway therethrough. The members **102, 104, 106** are substantially identical and typically include opposite planar, generally parallel faces **108, 110** bounded by opposite side edges **112, 114.** The members are tapered or nosed at each end **116, 118** to provide smooth fluid pressure transitions at the ends. Faces **108** and **110** include projections **120** thereon extending outwardly from the surfaces and disposed perpendicularly to the longitudinal axis of the member. As described in connection with projections **30** on rod **10,** projections **120** (generally **2–3** on each face along the member length) increase fluid turbulence over the faces, thereby increasing the effective fluid contact areas of these faces. The projections are generally disposed at the same longitudinal locations along the member length on each face **108, 110,** although such disposition is not necessary.

To assemble rod **100,** members **102** and **104** are placed in a suitable jig in a general V configuration with side edge **112** of member **102** in surface-to-surface contact with face **108** of member **104** adjacent side edge **114** of member **104.** To aid in assembling the members, side edge **112** on each member is beveled at about a 60° angle to face **110.** The members are constrained against relative longitudinal shifting by coacting means **122** consisting of ears **124** and notches **126.** Specifically, as can be seen most clearly in FIG. **6,** each member includes at least two ears **124** extending sidewardly from side edge **112** and at least two notches **126** in side edge **114.** As can be seen in FIGS. **6** and **7,** the ears and notches are located in transverse alignment along the longitudinal extent of the members such that when the members are assembled, the ears fit snugly within and interlock with the notches. Thus, when assembling members **102** and **104,** ears **124** of member **102** engage notches **126** of member **104.** It is desirable to braze the ears in the notches to maintain the relative V configuration of members **102** and **104** during the assembly of the rod **100.** Of course, it will be appreciated that the coacting means need not be interlocking means such as are preferred herein, but may be any means, such as welds, which will prevent relative longitudinal shifting of the members. The next step in assembling rod **100** is to assemble member **106** to the V configuration of members **102** and **104** to complete the triangular periphery of the rod **100.** To accomplish this, beveled side edge **112** of member **106** is placed into surface-to-surface contact with face **108** of member **102** adjacent side edge **114** of member **102** with ears **124** of member **106** engaging notches **126** of member **102.** At the same time, beveled side edge **112** of member **104** comes into surface-to-surface contact with face **108** of member **106** adjacent side edge **114** of member **106** with ears **124** of member **104** engaging notches **126** of member **106.** It is then desirable to braze the remaining unbrazed interlocked ears and notches to provide a firm triangular rod configuration. A triangular passageway **128** extending longitudinal through rod **100** is defined by intersecting walls **108** of the members to furnish an additional fluid flow channel.

In use, rod **100,** like rod **10** is inserted and retained within a casing **150,** which may include external threads **152** at one or both ends of the casing, and is then installed in a flow system. Rod **100** is preferably retained within casing **150** by circumferential washers **154** welded or otherwise secured to the inner wall **156** of the casing near the nosed ends **116, 118** of the rod. To insert rod **100** within casing **150,** a washer **154** is first secured to wall **156** after which nosed end **116** is directed into the casing until it abuts the inner diameter of the washer. The rod is held securely in place by inserting a second washer **154** into casing **150** over nosed end **118** and then securing the second washer to wall **156.** Inasmuch as the casings employed are generally cylindrical, it is desirable to provide a convexly arcuate bevel along side edge **114** of members **102, 104** and **106** to improve the fit of rod **100** within the casing. Likewise, it is desirable that ears **124** include a surface **130** coplanar with face **108** and a convexly arcuate wall **132** extending between surface **130** and face **110.** The curvature of wall **132** generally corresponds to the curvature of the bevel of side edge **114** such that the triangular apices defined by the intersection of members **102, 104** and **106** are convexly curved to more readily conform to the casing wall.

Notwithstanding that the walls of rod **100** are not arcuate, sufficient wall surface area and flow area is provided in rod **100** to assure a minimum pressure drop across the rod length and to achieve polarization of the minerals in the fluid flowing over the rod. Thus, the same beneficial effects are realized with rod **100** as with rod **10.** The primary advantage of rod **100** is that it can be manufactured by casting in three pieces rather than as a single unitary piece. It has been found, particularly with rods having diameters greater than about 6 inches, that a unitary casting is extremely heavy and difficult to handle. Moreover, as a practical matter, it is difficult if not impossible to cast a rod which is so large. Thus, the multielement configuration of rod **100** becomes more and more desirable as the rod diameter increases.

The fluid stabilizing rods of the present invention are formed of an alloy of copper, zinc, nickel and tin by melting the alloy at about 1,900°–2,100°F. and then sand casting the rods to the desired shape. Effective rod compositions are in the range, by weight, of 40–50 percent copper, 20–30 percent zinc, 15–25 percent nickel and 9–15 percent tin. A particularly preferred composition is 45 percent copper, 25 percent zinc, 20 percent nickel and 10 percent tin. Rods having compositions in the aforementioned ranges have been found to be substantially non-sacrificial or only slowly sacrificial with useful lives in normal use up to about 10 years.

While the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope thereof. Accordingly, all modifications and equivalents may be resorted to which fall within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An elongated tubular stabilizer rod adapted for insertion into a conduit having fluid flowing therein comprising at least three identical elongated, generally planar side members, each of said members including a pair of opposite generally planar faces and opposite side longitudinal edges, a plurality of projections disposed transversely to the longitudinal extent of said members extending outwardly from each of said faces, said side members being positioned to form a tubular rod including at least three lengthwise extending adjacent peripheral side walls defined by said members, said members defining therebetween a lengthwise extending passageway for the flow of fluids therein, adjacent longitudinal side edges of said members including means constraining said members against relative longitudinal shifting.

2. A rod, as claimed in claim **1**, wherein said means comprises a plurality of ears extending outwardly from one longitudinal side edge of each member and a corresponding plurality of notches formed in the other longitudinal side edge of each member, said ears and notches on adjacent members being in longitudinal registry and engaged.

3. An elongated tubular stabilizer rod adapted for insertion into a conduit having fluid flowing therein, said rod being an alloy of copper, zinc, nickel and tin and comprising at least three elongated, generally planar side members, each of said members including a pair of opposite generally planar faces and opposite side longitudinal edges, a plurality of projections disposed transversely to the longitudinal extent of said members extending outwardly from each of said faces, said side members being positioned to form a tubular rod including at least three lengthwise extending adjacent peripheral side walls defined by said members, said members defining therebetween a lengthwise extending passageway for the flow of fluids therein, adjacent longitudinal side edges of said members including means constraining said members against relative longitudinal shifting.

4. A rod, as claimed in claim **3**, wherein said rod has a composition of, by weight, 40–50 percent copper, 20–30 percent zinc, 15–25 percent nickel and 9–15 percent tin.

5. A rod, as claimed in claim **4**, wherein said rod has a composition of, by weight, 45 percent copper, 25 percent zinc, 20 percent nickel, and 10 percent tin.

6. A rod, as claimed in claim **1**, wherein one longitudinal side edge of each member is beveled for generally surface-to-surface seating against the passageway-defining surface of the adjacent member and said beveled edge is seated upon said passageway-defining surface.

7. A rod, as claimed in claim **6**, wherein the other longitudinal side edge of each member is convexly arcuate.

8. A rod, as claimed in claim **6**, wherein said means comprises coacting means interlocking said adjacent side members against relative longitudinal shifting.

9. A rod, as claimed in claim **8**, wherein said coacting means comprises a plurality of ears extending outwardly from said one longitudinal side edge of each member and a corresponding plurality of notches in the other longitudinal side edge of each member, said ears and notches on adjacent members being in longitudinal registry and engaged when said one longitudinal edge is seated along said other longitudinal side edge on the passageway-defining surface of the adjacent member.

10. A rod, as claimed in claim **1**, wherein said rod comprises three identical side members, said means comprises a plurality of ears on one longitudinal side edge of each said member and a plurality of notches on the other longitudinal side edge of each said member, said ears on said one longitudinal side edge of one member engaging said notches on the adjacent longitudinal side edge of said adjacent member.

11. A rod, as claimed in claim **10**, wherein said rod has a composition of, by weight, 40–50 percent copper, 20–30 percent zinc, 15–25 percent nickel and 9–15 percent tin.

12. A rod, as claimed in claim **11**, wherein the longitudinal side edge supporting said ears is beveled for generally surface-to-surface seating against the passageway-defining surface of the adjacent member and said beveled edge is seated upon said passageway-defining surface.

13. In combination with a cylindrical casing therefor, an elongated tubular fluid stabilizing rod and means for constraining said rod against relative longitudinal shifting in said casing,

said rod having at least three elongated, generally planar side members, each of said members including a pair of opposite generally planar faces and opposite side longitudinal edges, a plurality of projections disposed transversely to the longitudinal extent of said members extending outwardly from each of said faces, said side members being positioned to form a tubular rod including at least three lengthwise extending adjacent peripheral side walls defined by said members, said members defining therebetween a lengthwise extending passageway for the flow of fluids through said casing, adjacent longitudinal side edges of said members including means constraining said members against longitudinal shifting relative to each other, said rod being surrounded by said casing and said side members defining with the inner wall of said casing additional passageways for the flow of fluids through said casing.

14. Apparatus, as claimed in claim **13**, wherein said rod is an alloy of copper, zinc, nickel and tin.

15. Apparatus, as claimed in claim **14**, wherein said rod has a composition of, by weight, 40–50 percent copper, 20–30 percent zinc, 15–25 percent nickel and 9–15 percent tin.

16. Apparatus, as claimed in claim **15**, wherein said rod has a composition of, by weight, 45 percent copper, 25 percent zinc, 20 percent nickel, and 10 percent tin.

17. Apparatus, as claimed in claim **13**, wherein said means constraining said members comprises a plurality of ears on one longitudinal side edge of each said member and a plurality of notches on the other longitudinal side edge of each said member, said ears on said one longitudinal side edge engaging said notches on the adjacent longitudinal side edge.

18. Apparatus, as claimed in claim **17**, wherein said rod has a composition of, by weight, 40–50 percent copper, 20–30 percent zinc, 15–25 percent nickel and 9–15 percent tin.

19. Apparatus, as claimed in claim 18, wherein the longitudinal side edge supporting said ears is beveled for generally surface-to-surface seating against the passageway-defining surface of the adjacent member and said beveled edge is seated upon said passageway-defining surface.

20. Apparatus, as claimed in claim 19, wherein the other longitudinal side edge of each member is convexly arcuate.

21. Apparatus, as claimed in claim 18, wherein said rod is generally triangular in cross section and comprises three identical side members defining therebetween a generally triangular passageway for fluid flow in said casing.

22. Apparatus, as claimed in claim 19, wherein said rod is generally triangular in cross section and comprises three identical side members defining therebetween a generally triangular passageway for fluid flow in said casing.

23. Apparatus, as claimed in claim 20, wherein said rod is generally triangular in cross section and comprises three identical side members defining therebetween a generally triangular passageway for fluid flow in said casing.

24. Apparatus, as claimed in claim 23, wherein said means constraining said rod comprises washer means secured within said casing spaced longitudinally inwardly away from each end of said rod whereby the ends of said rod project through said washer means.

25. Apparatus, as claimed in claim 24, wherein said rod has nosed ends and is disposed in said casing with said ends projecting through said washer means.

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