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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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(54) Title: BEADED MATRIX AND METHOD OF PRODUCING THE SAME

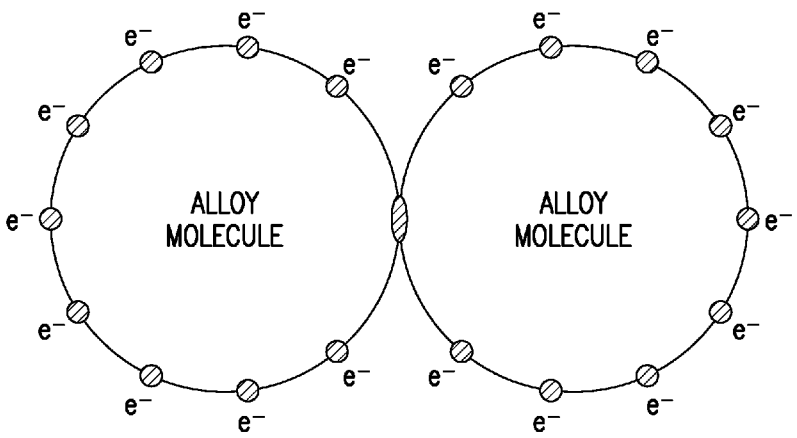


FIG.3

(57) Abstract: A method for making a beaded matrix includes positioning two or more beads near one another. Accelerating the two or more beads toward one another; and impacting the two or more beads with one another so that electrons are shared between molecules thereby fusing the two or more beads together.

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BEADED MATRIX AND METHOD OF PRODUCING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 14/298248, filed on June 6, 2014, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] In the downhole exploration and production industry, the movement and production of fluids is central to virtually all relevant operations. In many cases, the fluids that are moved would entrain solids. While in some cases, the entrainment of solids is desirable, such as in gravel and frac packing operations, such entrainment is often undesirable in other operations. One example, of course, is formation sand entrained with the production fluid. This is clearly undesirable as it is both a contaminant in the produced stream and also contributes to expedited wear of downhole components due to a sand blasting effect. Filtering assemblies are consequently used ubiquitously in the industry to remove these entrained solids. Sand screens have been used for decades and generally work well for their intended purposes. More recently, different operating parameters has supported interest in other filtering media such as beaded matrix assemblies.

[0003] Beaded matrix assemblies comprise a number of rounded beads that are typically braised together to form a porous solid that is configured during the manufacturing process to fit into a selected housing. One drawback is the impact that the braze has on the porosity of the beaded matrix since the braze itself requires a minimum surface area contact to be strong and is difficult to control as it flows. Braze itself also renders beaded matrixes not NACE compliant, which is increasingly important in downhole installations. Another drawback is that the heat of brazing can be deleterious to the longevity of the resulting products. Since downhole assemblies are long term installations, improvements are always welcomed by the art.

BRIEF DESCRIPTION

[0004] A method for making a beaded matrix includes positioning two or more beads near one another; accelerating the two or more beads toward one another; and impacting the two or more beads with one another so that electrons are shared between molecules thereby fusing the two or more beads together.

[0005] A downhole system includes a tubular string positioned in a borehole; and one or more beaded matrix assemblies in fluid communication with the string, the one or more assemblies having two or more beads sharing electrons between their respective molecules forming the matrix.

[0006] A NACE compliant downhole system includes a tubular string positioned in a borehole; one or more beaded matrix assemblies in fluid communication with the string, the one or more assemblies having two or more beads sharing electrons between their respective molecules forming the matrix; and an absence of NACE noncompliant materials in the beaded matrix assemblies.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 illustrates a beaded matrix in a housing;

[0008] Figure 2 illustrated the surface contact between adjacent beads and in broken lines where a braze bridge would be if bonded with braze rather than the molecular bond taught herein;

[0009] Figure 3 illustrates a molecular interface where electrons are shared between adjacent molecules;

[0010] Figure 4 is a schematic illustration of a thin layer of beaded matrix; and

[0011] Figure 5 schematically illustrates a downhole system including a beaded matrix as disclosed herein.

DETAILED DESCRIPTION

[0012] Referring to Figure 1, a beaded matrix 10 is illustrated within a housing 12. The illustration will be recognized from earlier filings in appearance but the matrix illustrated here is not prior art. Rather it is an improved matrix having enhanced porosity and greater longevity due to avoidance of braze material and avoidance of a heat affected zone caused by heat during the manufacturing process. More specifically, because there is no need to employ a binding composition such as braze, there is nothing to impact the porosity that the beads 14 and 16 themselves create when touching one another without perfectly nesting as will be appreciated by one of skill in the art. Brazed beads require sufficient braze 18 to bond the beads together and necessarily the braze will bridge small gaps where the beads are being bonded together, see broken lines in Figure 2 which otherwise is intended simply to illustrate a contact point between adjacent beads whereat bonding will take place without braze in accordance with the teachings herein.

[0013] The matrix illustrated herein is produced by collecting together a number of beads 14, 16, etc. each comprising a metal alloy, and joining the beads to one another at contact points by magnetic pulse welding or electrohydraulic forming. The processes employed are commercially available from BMAX ZI Thibaud 30 Bd de Thibaud, Toulouse France and utilize a magnetic field in a magnetic pulse welding operation or a hydraulic shock wave in an electrohydraulic forming operation in order to accelerate adjacent components, here the beads, (and hence their molecules) into one another such that the resulting collision causes the molecules to share electrons in their outer valences, see figure 3, effectively fusing the molecules together. The fusion is stronger than the base material and yet imposes no ill effect on the base material as would a heat based fusion method. In fact, heat is not applied at all and the fusion takes place at around room temperature so there is no heat affected zone. The bond is stronger than the base material, is completely durable and does not result in a new alloy at the joint. It is also rapid and so enhances efficient manufacturing production times.

[0014] In some embodiments the beaded matrix is formed in thin layers, see Figure 4, that are subsequently stacked to produce a beaded matrix thickness of a desired measurement that may be about ½ inch to about ¾ inch but is not limited to these measurements. In other embodiments, the matrix is formed as one piece in the desired measurement.

[0015] In one embodiment the matrix is formed and positioned within a housing, such as that shown in figure 1 or alternatively with added screen material on one or each axial end of the housing. The housing may be preformed or may be formed around the beaded matrix by traditional welding, crimping (conventional processing) or by magnetic pulse welding or electrohydraulic forming. The housing provides the structure to mount the matrix to a downhole component reliably. For example, in some embodiments the housing will be threaded at the outside diameter thereof to screw into a downhole component for mounting thereat.

[0016] One advantage of the configuration and method disclosed herein is that the resulting beaded matrixes (using for example nickel chromium alloys or nickel alloys) are NACE compliant which has never been possible in the art because of the braze that has heretofore always been required in order to produce any kind of beaded matrix. Another benefit of the present invention is that the pressure ratings of beaded matrixes produced as taught herein are vastly superior to those of beaded matrixes of the prior art. The pressure ratings achievable with the beaded matrixes of the invention are on the order of six times the

psi ratings braze based matrixes normally attain which are limited to on the order of 5,000 psi to 10,000 psi depending of the geometry and size of the media.

[0017] Referring to Figure 5, the inventive beaded matrix is schematically illustrated in a downhole string showing the action of the beaded matrix in filtering incoming production fluids. Utilizing the beaded matrixes disclosed herein, an operator is able to construct a borehole system having superior pressure capability, longevity and flow capability than possible with systems of the prior art. This is in addition to being NACE compliant, which is a clear advantage to any operator in today's downhole industry.

CLAIMS

What is claimed is:

1 A method for making a beaded matrix comprising:

positioning two or more beads near one another;

accelerating the two or more beads toward one another; and

impacting the two or more beads with one another so that electrons are shared between molecules thereby fusing the two or more beads together.

2 A method for making a beaded matrix as claimed in claim 1 wherein the accelerating is by a magnetic pulse welding operation.

3 A method for making a beaded matrix as claimed in claim 1 wherein the accelerating is by an electrohydraulic forming operation.

4 A method for making a beaded matrix as claimed in claim 1 wherein the two or more beads are arranged in a thin layer of beads and subsequent to accelerating and impacting, two or more layers are stacked to form a beaded matrix having a selected thickness dimension.

5 A method for making a beaded matrix as claimed in claim 1 wherein the method further comprises producing a housing around the beaded matrix.

6 A method for making a beaded matrix as claimed in claim 5 wherein the producing is by a magnetic pulse welding operation.

7 A method for making a beaded matrix as claimed in claim 5 wherein the producing is by an electrohydraulic forming operation.

8 A method for making a beaded matrix as claimed in claim 5 wherein the producing is by a conventional process.

9 A beaded matrix assembly comprising:

two or more beads sharing electrons between their respective molecules forming a matrix.

10 A beaded matrix assembly as claimed in claim 9 further including a housing disposed about the matrix.

11 A beaded matrix assembly as claimed in claim 10 wherein the assembly is rated to greater than 15,000 psi.

12 A beaded matrix assembly as claimed in claim 10 wherein the housing includes a screen on at least one axial end of the housing.

13 A beaded matrix assembly as claimed in claim 10 wherein the housing includes a screen on both axial ends of the housing.

14 A downhole system comprising:

a tubular string positioned in a borehole; and

one or more beaded matrix assemblies in fluid communication with the string, the one or more assemblies having two or more beads sharing electrons between their respective molecules forming the matrix.

15 A NACE compliant downhole system comprising:

a tubular string positioned in a borehole;

one or more beaded matrix assemblies in fluid communication with the string, the one or more assemblies having two or more beads sharing electrons between their respective molecules forming the matrix; and

an absence of NACE noncompliant materials in the beaded matrix assemblies.

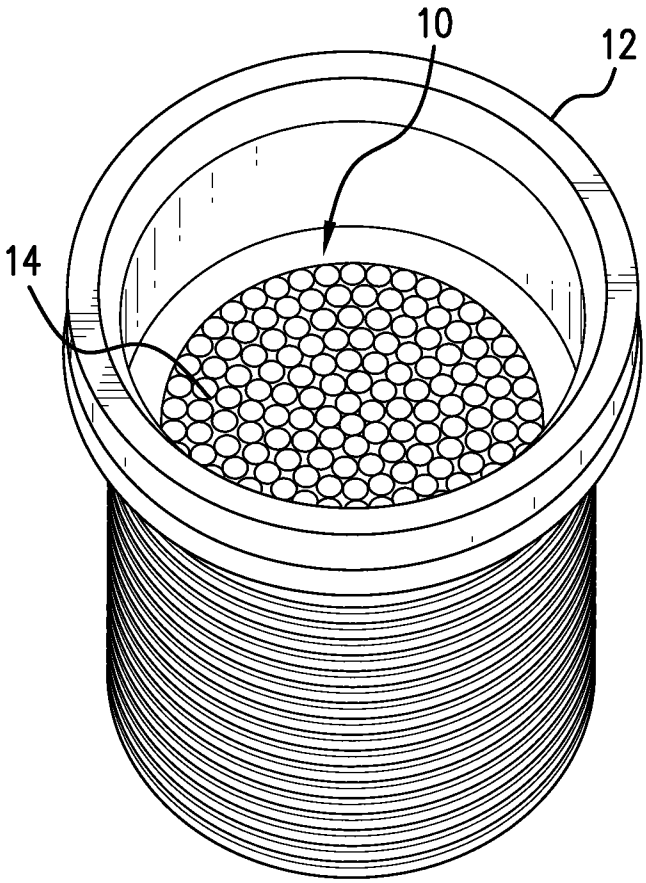


FIG. 1

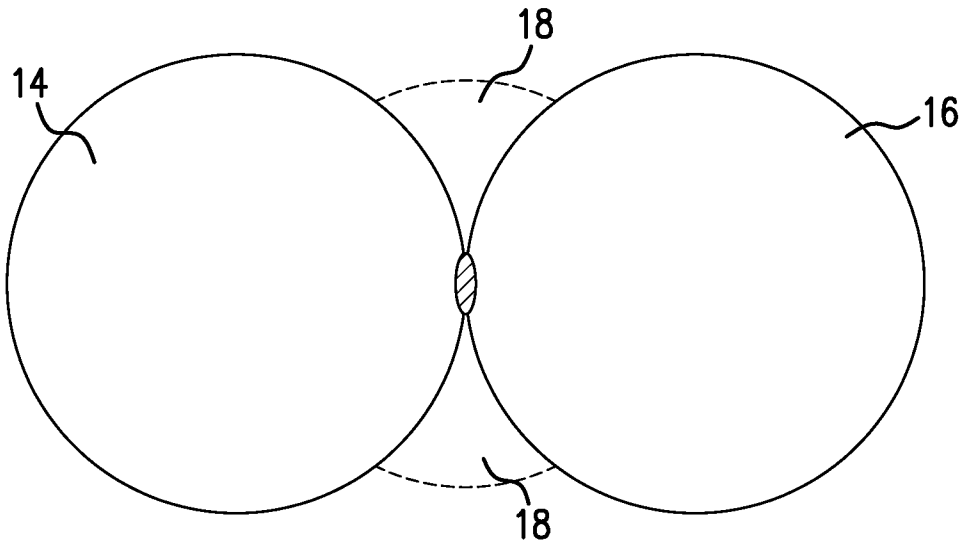


FIG.2

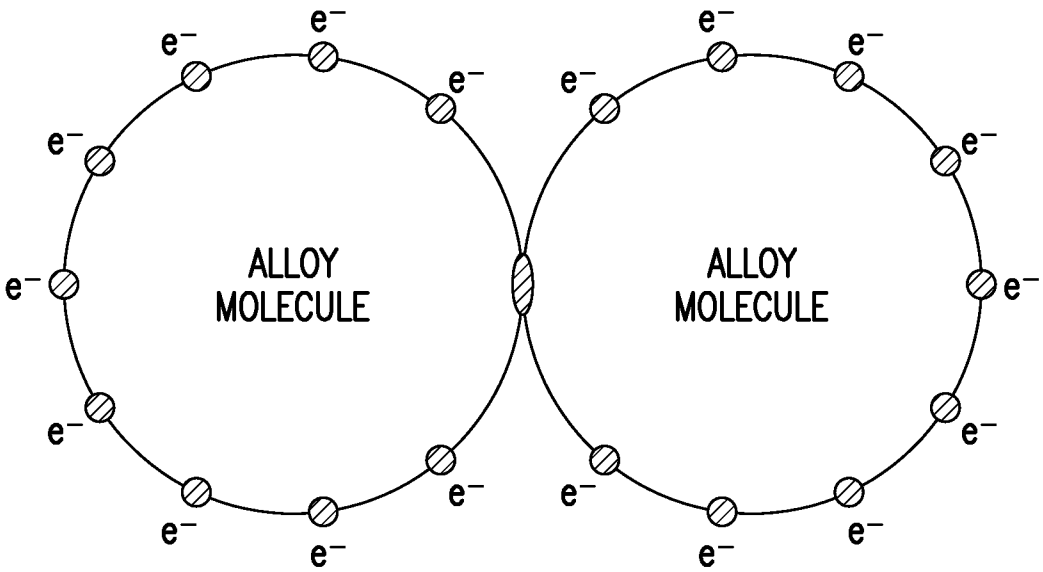


FIG.3

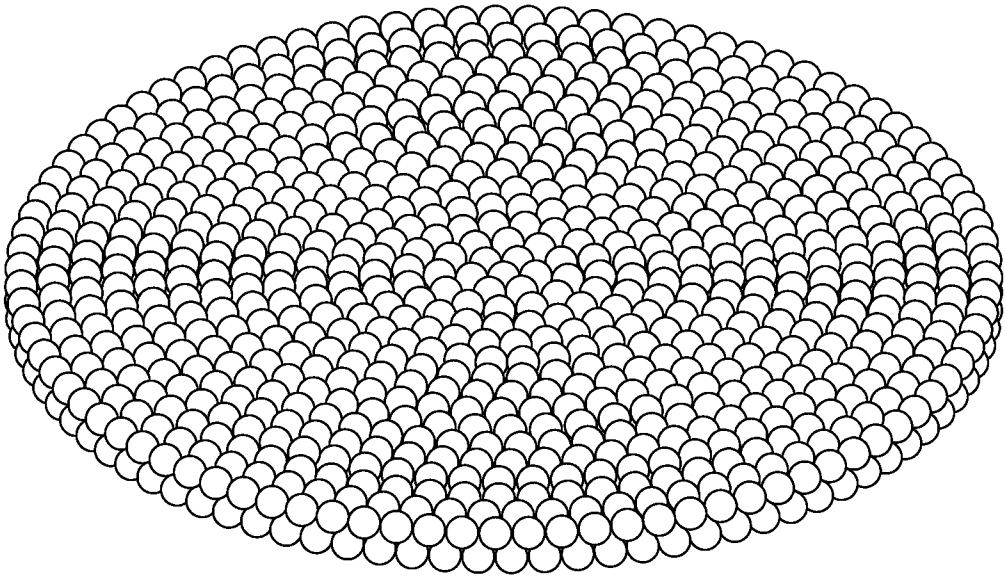


FIG.4

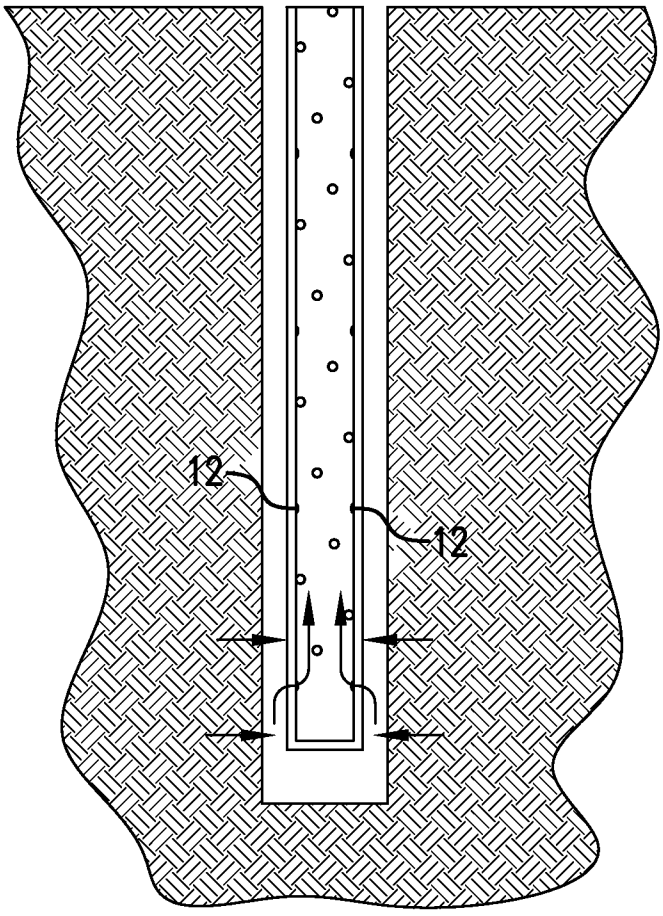


FIG.5

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

B22F 7/06(2006.01)i, B22F 3/12(2006.01)i, E21B 10/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B22F 7/06; B23K 20/06; E21B 33/13; B23K 20/08; E21B 43/26; E21B 43/08; B22F 3/12; E21B 10/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: bead, matrix, fusing, magnetic pulse welding, electrohydraulic forming, screen, housing, electron, and downhole system

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 8056627 B2 (JOHNSON et al.) 15 November 2011 See column 2, lines 27-55, column 3, line 35 - column 5, line 20, claims 1,7, and figure 3.	1-15
Y	EP 1834727 A2 (THE GENERAL ELECTRIC COMPANY) 19 September 2007 See paragraphs [0013]-[0014] and claims 1, 3, 5.	1-15
Y	US 7913755 B2 (JOHNSON, MICHAEL H.) 29 March 2011 See claim 1 and figure 5.	12-13
A	US 2004-0089698 A1 (CERMAK et al.) 13 May 2004 See paragraphs [0014], [0032]-[0034] and claim 1.	1-15
A	US 2010-0012323 A1 (HOLMES et al.) 21 January 2010 See paragraphs [0002]-[0004], [0023] and claim 1.	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2015 (31.07.2015)	**31 July 2015 (31.07.2015)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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