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FILTER MEANS FOR DUCT-FORMING DEVICES

Filed Jan. 20, 1966

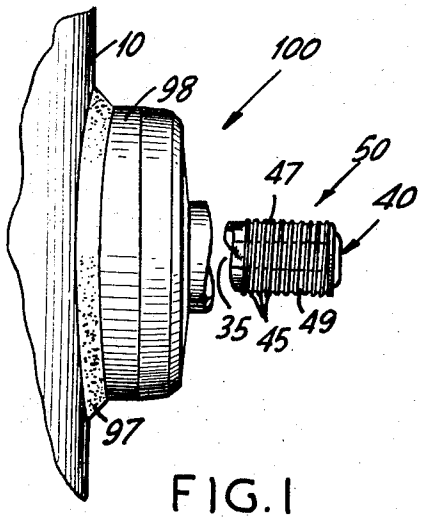


FIG. 1

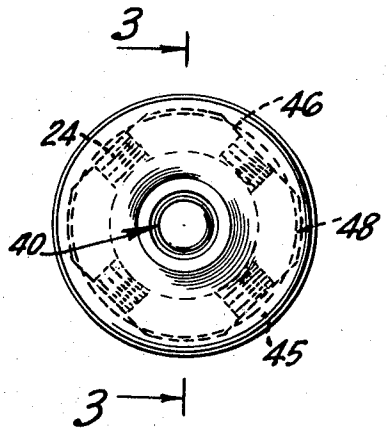


FIG. 2

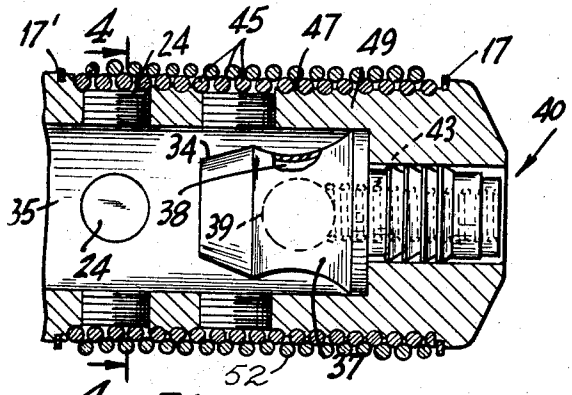


FIG. 3

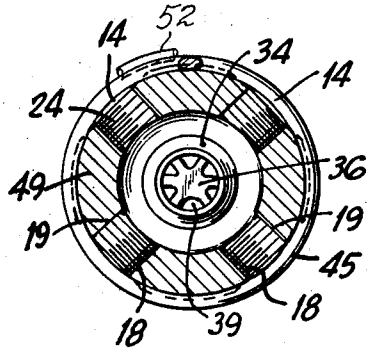


FIG. 4

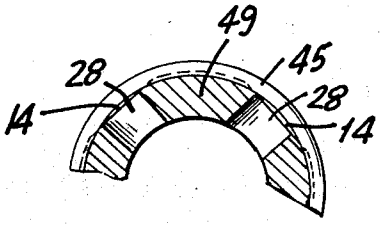


FIG. 6

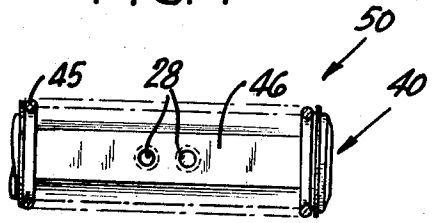


FIG. 5

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FILTER MEANS FOR DUCT-FORMING DEVICES

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ABSTRACT OF THE DISCLOSURE

A filtering device for use in well completion apparatus of the kind wherein a bore hole casing is positioned in a bore hole and duct-forming devices of acid-resistant metal are secured to the casing in alignment with the holes machined in the casing wall, the duct-forming devices including terminal tubes which are capable of being laterally extended for making contact with a producing formation. The tubes which are intended to make contact with the producing formation are at least partially enveloped by acid-resistant wire which is wrapped around the exterior surface of the tubes and secured thereto. The individual courses or turns of the wire are closely spaced in equidistant manner so as to form a dense coil or helix around the circumference of the tube. The tube body proper is traversed by a plurality of passageways in the form of holes or bores which are initially plugged by acid-soluble plugs. When the device is to be put in operation, the plugs are dissolved by acid.

This invention generally relates to filtering devices and is particularly concerned with filters for use in conjunction with well completion apparatus of the kind wherein duct-forming elements are secured to a bore hole casing or liner and may be caused to project laterally from the casing to make contact with a producing zone of the formation.

Until recently, bore hole casings or liners have been set in bore holes by a cementing process in which a cement slurry is forced down through the casing and then upwardly around the outside of the casing to fill the annular space between the exterior casing surface and the surrounding wall of the formation. After solidification of the cement, communication between the casing and the producing zone was established by explosive perforation of the casing, e.g. by means of bullets or shaped charges which also penetrated the hardened cement to form passageways or ducts therethrough. This procedure is unsatisfactory as the bullets or charges tend to crack the cement around the passageways, thereby causing vertical communication, to wit, up and down movement around the casing from one perforation to another. This, in turn, prevents later selective treatment through each perforation to the formation at the end of each duct or perforation, since injected treating material could travel up or down through cracked cement without permitting selective control at the injected places; i.e. the stratum of the formation at the end of each duct.

More recently, an improved method and device for establishing communication between the casing and the producing zone has been suggested. According to this suggestion, a plurality of duct-forming devices are welded or otherwise secured to the outside of the casing in alignment with holes machined into the casing wall. These duct-forming devices comprise telescoping tubes or sleeves which are in a retracted position during that positioning of the casing in the bore hole. When contact with a producing zone is to be made, these telescoping tubes are caused to project substantially horizontally toward the formation wall to make contact with the pay zone and to

establish a permanent link between the pay zone and the casing. The cement slurry is introduced into the space between the casing and the formation wall either before or after the lateral telescoping of the tubes so that the cement sets around the tubes and the casing. The telescoping tubes of the duct-forming devices, as previously proposed, are made of steel or the like acid resistant metal and the tubes which utimately contact the producing formation are blocked by acid soluble metal plugs which are lodged within the tube in a sealing manner so as temporarily to prevent passage of material through the tube. When communication between the pay zone and the interior of the casing is to be established, acid is introduced into the casing and into the laterally extending telescoping tubes to cause dissolution of the plugs.

Upon dissolution of the metal plugs by the acid petroleum or gas can then freely enter the duct-forming device and thus the casing. On the other hand, if the producing formation is to be treated or stimulated, suitable fluids may be pumped through the casing and the duct-forming devices under pressure for exit toward and into the formation.

Many petroleum or gas producing formations are of sandy nature with the result that the fluid entering the duct-forming device is contaminated sand and the like solid particles. Efforts have therefore been made to prevent the entry of the solid particles into the casing since they, of course, are undesired contaminants which complicate the further processing of the petroleum or gas. According to prior art proposals the solid particles are filter out by disk or plate shaped filters which are mounted across the cross second of the interior flow passage of the duct-forming device. Another prior art suggestion is to place a plurality of beads or the like solid shapes within the flow passage in order to filter out solid matter which may accompanying the entering fluid. However, experience has demonstrated that the arrangement of filter disks or plates or beads within the flow passage of the duct-forming device does not yield satisfactory results primarily for the reason that solid matter builds upon the surface of the filtering disks or around the beads which ultimately forms a dense plug or cake preventing flow of the fluid through the duct-forming device. In addition, it is difficult and extensive to construct duct-forming devices with interior filtering means.

Another disadvantage of prior art filter constructions arranged within the flow passage of the duct-forming device is that they are not effective to filter out very line sand particles, usually referred to as fines. The particle size of fines is about 0.029 inch (200 mesh) and conventional filters cannot readily be manufactured for filtering out such extremely small solid particles.

Accordingly, it is a primary object of this invention to overcome the disadvantages and drawbacks of the prior art filter constructions and to provide a filter which is located outside the flow passage of the duct-forming device and which effectively prevents entry of solid matter into the flow passage.

Another object of this invention is to provide a duct-forming device including filtering means which is superior to prior art constructions of this nature, which can be manufactured inexpensively and which is of rugged and simple construction.

It is also an object of this invention to provide a combined filter-duct-forming device which is capable of filtering out fines without impeding the flow of the fluid into the flow passage of the duct-forming device.

Still a further object of the invention is to provide a combined filter and duct-forming device of the indicated nature which is fitted with flow restricting means at the end closest to the formation for permitting restricted flow of fluid from the casing through the flow passage of the

duct-forming device and towards and into the producing formation while preventing entry of fluid from the outside into the flow passage of the device.

Generally, it is an object of this invention to improve on the art of duct-forming devices having filtering means as presently practiced.

Briefly and in accordance with this invention, the outermost or terminal tube of the duct-forming device, to wit, the tube which is intended to make contact with the producing formation, is at least partially enveloped by acid resistant wire which is wrapped around the exterior surface of the tube and secured thereto. The individual courses or turns of the wire are closely spaced in equidistant manner so as to form a dense coil or helix around the circumference of the tube. The tube body proper is traversed by a plurality of passageway means, preferably in the form of holes or bores which are plugged by acid soluble blocking means such as plugs. When communication with the producing formation is to be established, acid is introduced into the flow passage of the duct-forming device, to dissolve and disintegrate the acid soluble plugs thereby exposing the holes passing through the tube wall. Instead of plugs (an acid soluble blocking means in the form of an insert positioned within the flow passage and covering the holes or bores may be provided. Since the wire coil or helix wrapped around the tube exterior is of acid resistant material, the wires remain intact as a filter or strainer to prevent entry of solid material which is contained in the fluid flowing through the holes into the flow passage of the duct-forming device.

According to a preferred embodiment of the invention, the exterior surface of the tube is formed with one or several fluid courses which may be in the form of longitudinal grooves or flat surfaces extending lengthwise of the tube, the holes or bores traversing the tube body between the fluid courses and the flow passage. These fluid courses, upon dissolution of the blocking means, to wit, the insert or the plugs facilitate the flow of fluid and thus the operation and efficiency of the duct-forming device. The formation of flat surfaces to yield fluid courses is effected by cutting away a portion of the exterior wall on the tube. These fluid courses have the additional advantages that the wire filter located above the holes will be slightly spaced from the holes proper, while at the same time effectively preventing the entry of solid matter into the duct-forming device.

In order securely to lodge the enveloping wire or helix and to facilitate equal spacing between the individual adjacent wire turns, the exterior surface of the tube is advantageously grooved in a continuous thread-like manner, the grooves acting as guideways or supports for the wire. The grooves should be relatively shallow so that only a portion of the wire is positioned therein. However, the fluid courses could be devoid of such grooves.

In a preferred embodiment, the depth of the grooves is chosen so that about one third of the wire is lodged within the grooves, the remaining two thirds projecting above the exterior tube surface.

With a view to effectively filtering fines, it has been established that excellent results are obtained if the spacing between the individual wire turns is about 0.003 inch while the diameter of the wire is 0.031 inch. Consequently, with such wire size and groove spacing, the center planes between any adjacent two grooves will always be spaced by $0.003+0.031=0.034''$. The ends of the wire coils may be secured to the tube in any suitable manner such as, for example, by snap or split rings which are inserted into terminal grooves located adjacent both ends of the tube.

According to a further modification of the invention, the free end of the tube, to wit, the end closest to the formation is provided with flow restricting means which permit flow of pressurized fluid from the casing, through the flow passage and outwardly towards and into the formations while preventing entry of fluid from the outside into the flow passage. These flow restricting means which may be in the form of a ball check valve thus permit treatment of the formation by pumping liquid through the ball check valve towards and into the formation.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a fragmentary side elevation of a bore hole casing having a duct-forming device secured to its exterior surface, the duct-forming device including a terminal tube which is fitted with the inventive filtering means. In order not to crowd the drawing, those elements and mechanisms of the duct-forming which do not form part of this invention have been omitted;

FIG. 2 is an end view on enlarged scale of the free end of the terminal tube with the wire retaining snap ring being removed;

FIG. 3 is a section along the line III—III of FIG. 2;

FIG. 4 is a section along the line IV—IV of FIG. 3;

FIG. 5 is a plan view on the terminal tube with the extent of the wire helix shown in dot-dashed lines; and

FIG. 6 is a fragmentary sectional view corresponding essentially to FIG. 4 with the plugs being dissolved by acid.

Referring now to the drawings, a duct-forming device generally indicated by reference numeral **100** is welded or otherwise secured to the external surface of a bore hole casing **10**. The bore hole casing **10** has a hole or opening (not shown) which is in alignment with the flow passage **35** of the duct-forming device **100**. The general construction of the duct-forming device has not been illustrated.

The duct-forming device **100** is secured to the casing **10** by means of a nipple or mounting boss **98** which, in turn, is welded to the exterior casing surface as indicated by reference numeral **97**. The duct-forming device **100** projects laterally from the casing **10** and includes an outer or terminal tube generally indicated by reference numeral **50**. The tube **50** comprises a body member **49** of generally square cross section having, however, four rounded-off or curved corner portions **48**. The corner portions **48** are provided with relatively shallow grooves or threads **47**, while no grooves or threads are present on the straight, flat surfaces **46** of the body portion **49**. In practice, a cylindrical tube may be first grooved or threaded so as to form a continuous helix-like groove or thread over a major portion of the length of the tube, whereafter the tube is worked so as to cut away portions of the exterior wall and to form the four flat surfaces **46**. Wire, for example of tantalum, stainless steel or the like acid resistant metal is wrapped around the exterior of the tube **50**, the wire being indicated by reference numeral **45**. The wire may be precoiled and forms, in fact, a continuous helix, part of which is guided in and supported by the grooves **47**. Since the grooves are shallower than the thickness of the wire **45**, a major portion of the wires projects above the surface of the tube **50**. In a practical embodiment, the wire may have a diameter of 0.031 inch while the spacing between the individual wire turns may be 0.003 inch, about ⅓ of the wire being situated within the grooves. Slightly larger spacings may be chosen, dependent on the particular conditions.

The free end of the tube **50**, to wit, the end closest to the formation, is fitted with a ball check valve mechanism generally indiacted by reference numeral **40**. The ball check valve **40** comprises a valve body **37**, a valve chamber **38** and the ball **39**. The ball is retained within the chamber **38** by means of a star-shaped plate **36** as also seen in FIG. 4. The plate **36**, in turn, is secured to the valve body by means of a flange portion **34**. A com-

pression spring 43 urges the ball 39 against its seat (not shown). The ball check valve 40 may be screwed into the free end of the tube 50 but in the embodiment shown, it is driven in by hammer action in fluid tight manner. It will be noted that fluid may flow through the tube and out through the spring loaded ball check valve in the direction away from the tube, provided the force of the spring 43 is overcome, while fluid flow is prevented through the valve and into the flow passage 35 of the tube.

From a practical point of view, the tube may be formed with a ball check valve by first drilling a solid piece of metal to form an interior flow passage which is narrower at the terminal end of the tube whereafter the ball check valve is inserted as a separate element as shown in FIG. 3.

The flat surfaces 46 of the tube 50 are each provided with two holes 28, which are plugged by acid soluble plugs 24. In the embodiment here shown, hte plugs 24 have exterior threads 19 which mesh with interior threads 18 of the holes 28. However, it is also possible simply to drive the plugs into the holes. Although each flat surface is shown with two holes 28, one or several holes may be provided. It is, however, recommended that the total cross sectional area of the holes be approximately equal to the cross sectional area of the flow passage 35.

The ends of the wire helix 45 which is wrapped around the tube 50 are secured by means of snap rings 17 and 17'. The snap rings 17 and 17' are lodged in respective grooves and clamp the respective end of the helix. Of course, any other different suitable means for securing the wire helix 45 to the tube surface such as by welding or riveting is feasible. It should be noted tha tthe helix 45 is not resilient.

The operation of the device is as follows:

As the tube 50 has been projected into contact with the producing formation, acid is introduced into flow passage 35 of the tube. The acid dissolves and disintegrates the plugs of blocking means 24, thereby establishing communication between the formation and the passage 35. Fluid may thus flow from the outside through the holes 28 into the passage 35. However, since the closely spaced wires 45 cover the holes, solid matter which may be entrained in the incoming fluid is effectively filtered out and lodges itself on the wire surface. Coarser solid particles facilitate the retaining action by forming a particle retaining bridge between and adjacent the wire turns. In addition, the solid particles on the wire filter form a filter bed, thus increasing the filter action. It will be noted that no solid material enters the tube proper but all the strained material accumulates outside the duct-forming device.

The exterior flat, straight surfaces 46, through which the holes 28 extend, act as fluid courses which facilitate the flow of the fluid. These flat surfaces 46 also increase the distance of the wires 45 to the orifices of the holes 28. It will thus be noted that while the wire is in direct contact with the exterior surface of the tube at the curved portions 48 and the wire is partially lodged within the grooves 47, a clear space 14 is formed between the fluid courses 46 and the wires 45.

If the formation is to be treated or stimulated, liquid is pumped down the casing, through the flow passage 35 of the tube and the ball check valve 40 and into the formation, the check valve 40 permitting flow away from the tube. The information can thus be treated while the plugs 24 are being eaten out which increases the usefulness of the device. Liquid pumped through the valve 40 will also help to dissipate any accumulations of solid matter which may have been formed around the tube. Outward flow of fluid through the wires during treatment will also be able to move forwardly due to the above described fluid action through valve 40.

By contrast, since the ball check valve 40 prevents entry of fluid into the tube, no matter can enter through the ball check valve 40.

The terminal tube may be enveloped by an acid soluble perforated sheath or sleeve of zinc or the like acid soluble metal to facilitate the movement of acid reaching the exterior of the tube and by dissolution to create an enlarged area for filtration.

The provision of an acid soluble sheath is particularly recommended if the tube traverses and is embedded in cement located between the casing and the formation wall. In order to permit the petroleum gas to reach the filter area of the tube, a space must be present between the tube and the enveloping cement which is created by acid dissolution of the sheath. Instead of a sheath, acid soluble wire 52, see FIGS. 3 and 4, for example in the form of a helix, may be wrapped around the exterior of the tube above the acid resistant filter wire referred to. In such event the spaces between the individual turns of the acid resistant filter wire form guideways for the acid soluble wire helix 52 which will be dissolved by acid penetrating from the flow passage of the tube.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In well completion apparatus of the kind wherein a bore hole casing is adapted to be positioned in a bore hole and duct-forming devices of acid-resistant metal are secured to the casing in alignment with holes machined in the casing wall, each duct-forming device including a terminal tube which is capable of being laterally extended for making contact with a producing formation, the improvement which comprises that said tube is arranged to provide a closed outer end and includes an acid resistant body member defining an interior flow passage, filtering means secured to said body member and including a length of acid resistant metallic wire having an acid resisting characteristics at least substantially similar to that of stainless steel and wrapped around at least a portion of the exterior surface of said body member in closely spaced turns, said body member defining passageway means below said wire for establishing communication between said flow passage and the exterior of said body member, and acid soluble blocking means in said tube for blocking the communication between said flow passage and said passageway means, whereby upon dissolution of said acid soluble blocking means, communication between the exterior of said body member and the flow passage is established for permitting flow of fluid from the outside through said wire and said passageway means into said flow passage while solid matter is held back by said wire.

2. The improvement as claimed in claim 1, wherein the exterior surface of said body member defines a plurality of substantially equidistant closely spaced grooves, said wire being positioned in and supported by said grooves.

3. The improvement as claimed in claim 2, wherein the depth of the grooves is shallower than the diameter of the wire, whereby only the bottom portion of the wire is positioned in said grooves.

4. The improvement as claimed in claim 3, wherein the depth of said grooves is about one-third of the diameter of the wire.

5. The improvement as claimed in claim 1, wherein said wire essentially consists of tantalum or stainless steel.

6. The improvement as claimed in claim 1, wherein the diameter of the wire and the spacing between the individual turns of the wire are adapted so as to filter out solid particles of a size corresponding to about 200 mesh.

7. The improvement as claimed in claim 6, wherein said wire has a diameter of about 0.031 inch, the spacing between the individual turns being about between 0.003 and 0.004 inch.

8. The improvement as claimed in claim 1, wherein the exterior surface of said body member is provided

with means for forming at least one fluid course, said passageway means extending between said fluid course and said flow passage.

9. The improvement as claimed in claim 8, wherein said means for establishing a fluid course is at least one flat surface on the exterior surface of the body member, said flat surface being devoid of grooves.

10. The improvement as claimed in claim 1, wherein said length of wire is a helix with equidistant turns wrapped around the exterior surface of said body member and being secured thereto.

11. The improvement as claimed in claim 10, wherein said helix is precoiled.

12. The improvement as claimed in claim 10, wherein the ends of said helix are secured to the exterior surface of said body member by snap rings.

13. The improvement as claimed in claim 1, wherein said passageway means comprises a plurality of holes traversing the body member and communicating with said flow passage.

14. The improvement as claimed in claim 3, wherein said blocking means comprises acid soluble metal plugs inserted in said holes.

15. The improvement as claimed in claim 14, wherein said plugs have exterior threads which mesh with interior threads provided on the walls defining said holes.

16. The improvement as claimed in claim 1, wherein the end of said tube which is closest to the formation is provided with flow restricting means permitting flow under pressure through said flow passage in a direction away from said tube while preventing flow of fluid from the outside and into said flow passage.

17. The improvement as claimed in claim 16, wherein said flow restricting means is a ball check valve.

18. The improvement as claimed in claim 17, wherein the ball check valve contains spring means for urging the ball of the valve against its seat.

19. The improvement of claim 13, wherein the total cross sectional area of said holes is substantially equal to the cross sectional area of said flow passage.

20. In well completion apparatus of the kind, wherein a bore hole casing is adapted to be positioned in a bore hole and duct-forming devices of acid resistant metal are secured to the casing in alignment with holes machined in the casing wall, each duct-forming device including a terminal tube which is capable of being laterally extended for making contact with a producing formation, the improvement which comprises that said tube includes an acid resistant body member defining an exterior surface and an interior flow passage, said exterior surface being provided with a plurality of equidistant closely spaced grooves, a length of wire wrapped around said exterior surface and being located in and supported by said grooves to form a wire helix with closely spaced turns, said exterior surface forming at least one fluid course below said helix, at least one bore traversing said body member and establishing communication between said fluid course and said interior flow passage, acid soluble plug means located within said bore for blocking the communication between said flow passage and said fluid course, and flow restricting means at at least one end of said tube, said flow restricting means being in the form of a ball check valve which permits flow of pressurized fluid out of the tube while preventing flow of fluid from the exterior into the flow passage.

21. In well completion apparatus of the kind, wherein a bore hole casing is adapted to be positioned in a bore hole and duct-forming devices of acid resistant metal are secured to the casing in alignment with holes machined in the casing wall, each duct-forming device including a terminal tube which is capable of being laterally extended for making contact with a producing formation, the improvement which comprises that said tube is arranged to provide a closed outer end and includes an acid resistant body member defining an exterior surface and an interior flow passage, passageway means extending between said exterior surface and said interior flow passage, acid resistant metallic filter means having an acid resisting characteristic at least substantially similar to that of stainless steel and secured on said exterior surface and extending across said passageway means, and blocking means for temporarily blocking the communication between said exterior surface and said interior flow passage.

22. The improvement of claim 21, wherein acid soluble wire is wrapped around the exterior surface of the body member about said filter means for closing the openings through said filter means.

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U.S. Cl. X.R.

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