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(54) **SURFACE IMPROVEMENT FOR EROSION RESISTANCE**

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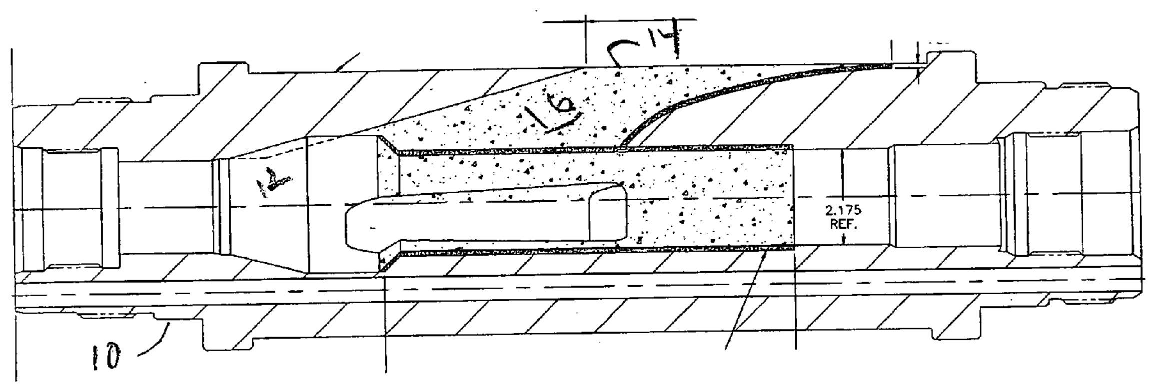
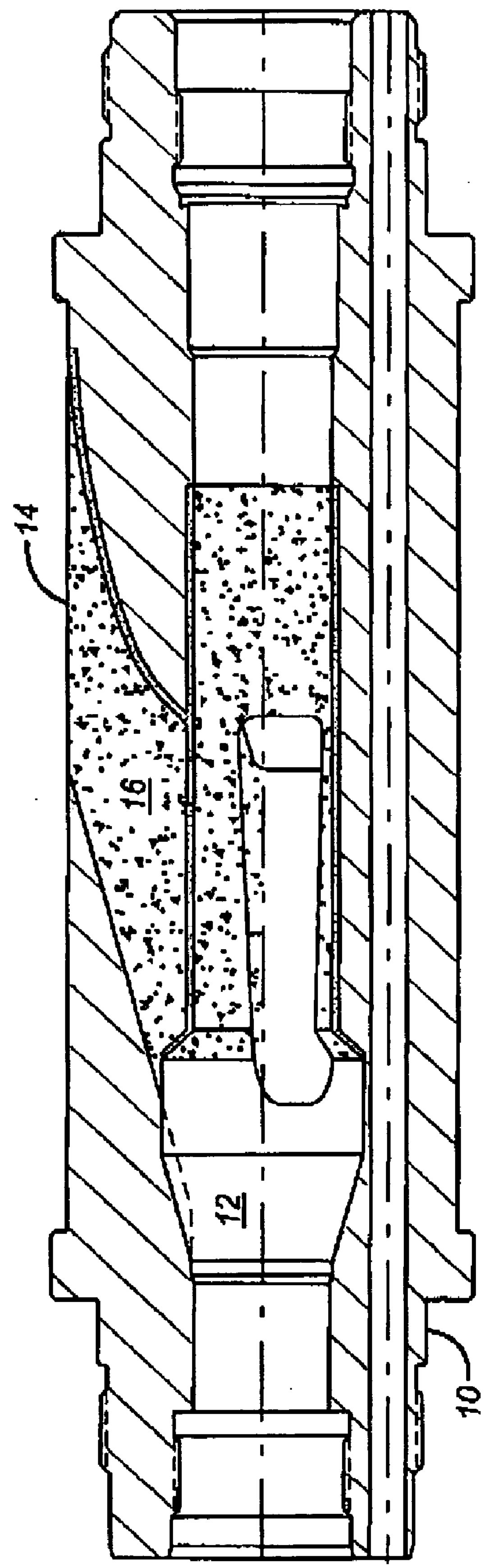
(57) **ABSTRACT**

The technique of laser induced surface improvement is used for tool surfaces in downhole tools that experience erosion from slurry or high velocity flows.

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SURFACE IMPROVEMENT FOR EROSION RESISTANCE

FIELD OF THE INVENTION

[0001] The field of this invention is surface improvements of parts of downhole tools that are subject to wear and erosion from fluid flow, including heavily laden fluids such as slurry, and more particularly to surface improvements applied with lasers.

BACKGROUND OF THE INVENTION

[0002] There are many downhole operations that involve slurry flow or high velocity gas flow with entrained solids. Such flows tend to remove metal from parts and can cause them to fail to operate or, in extreme cases, sever parts that may need to be fished or milled out. One common procedure is gravel packing through a crossover. This entails pumping gravel slurry past several bends to get it out from tubing and into the annular space defined by a surrounding casing. The crossover passages can exhibit high wear from the gravel impacts at relatively high velocities. Downhole choke valves generally have a ported cage moving to align the port thereon with an opening in the choke housing. The onset of flow as such valves open brings a rush of high velocity gas through an initially small opening. Here again, this mode of operation can cause severe wear from the erosion of the high velocity gasses.

[0003] In the past, the wear resistant surfaces were made from hard materials that resisted the erosive effects of the slurry flow. In some applications the wear surfaces were applied over a support surface and upon sufficient wear the remainder of the surface could be removed and replaced. These sacrificial liners were expensive to apply and replace and the present invention addresses the problem of economically increasing the life of components subjected to erosive forces due to slurry flows or high velocity gas flows downhole.

[0004] A technique called Laser Induced Surface Improvement (LISI) has been used to clad a surface with a metal coating and a binder that are alloyed to the surface using a laser. These techniques have been developed at the University of Tennessee with cooperation from the General Motors Corporation and have resulted in patents principally targeted to the automotive industry. The present invention seeks to apply this technique to downhole applications where erosion is a problem as an improvement to the existing technology of putting a hard surface in the wear zones.

[0005] Some patents that illustrate the LISI technique are U.S. Pat. Nos. 5,503,703; 5,961,861; 5,985,056; 6,016,227; 6,173,886; 6,223,137; 6,229,111; 6,284,067; 6,294,225; 6,299,707; 6,328,026; 6,350,326; 6,423,162; 6,497,985 and 6,660,692. These patents are all incorporated by reference as if fully set forth.

SUMMARY OF THE INVENTION

[0006] The technique of laser induced surface improvement is used for tool surfaces in downhole tools that experience erosion from slurry or high velocity flows.

BRIEF DESCRIPTION OF THE DRAWING

[0007] FIG. **1** illustrates a multi-port sub with the coating placed on it using the LISI technique.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] FIG. **1** illustrates a circulation sub **10** that has a central passage **12** and one or more lateral outlets **14**. Using the LISI process, a coating **16** is adhered to the surfaces that define the outlet **14**. Optionally, the wall of passage **12** can also be coated.

[0009] While a circulation sub is illustrated those skilled in the art will realize that other downhole tools that experience slurry flow that creates an erosion issue or high, velocity fluids can benefit from the wear coating adhered with the LISI process. The thickness and material selection can vary with the anticipated severity of the service and compatibility with fluids downhole.

[0010] Another downhole application is cross-over subs where gravel slurry goes from the tubing into the surrounding annulus. That flow can damage the ports or the opposing casing or control lines in the wall of the tool. Other applications involve sliding sleeves, frac nipples, seal bore surfaces, chokes and washout tools, to illustrate a few examples.

[0011] The LISI process improves surface properties such as hardness, wear resistance or corrosion resistance. In use the technique calls for application of a coating layer that is melted to the substrate so that the chemical composition or/and the microstructure of the substrate are altered. The underlying surface is preferably sand blasted, washed and then dried. A precursor which is a suspension of powder materials in a water soluble binder is prepared and sprayed on the surfaces to be treated in a thickness of about 50-150 μm and preferably less than 200 μm and then dried. The laser is then applied to unite the coating and the substrate. The surfaces coated can be flat, inner diameters or outer diameters, for example. The new surface after laser application can be sand blasted or left in its original state. Optionally, it can be textured on a steel substrate.

[0012] Some of the advantages of the LISI process are control of thickness and dilution of the layer secured by the process, an ability to focus on specifically targeted surfaces, the creation of a property modification of the surface, an environmentally friendly process with efficient material use, a broad range of substrates and reinforcement materials that can be integrated with them, rather small heat affected zones (under 10 microns) and a metallurgical bond so that the risk of delaminating is not present.

[0013] As a result of the LISI process the affected surface is hard, thick and dense while being metallurgically bonded while minimally damaging the underlying material. The process is flexible allowing for targeting of specific surfaces and options on coating selection such as WC, ZrO_2, TiN or CrB_2. There are a number of other material options including, but not limited to these carbides, ceramics, and oxides: CrB_2, Cr_3C_2, TiB2, Nb_2C, TiC, B_4C, SiC, Mo_2C, SiC, ZrB_2, WC, WZrC, MoB, TiB_2 or CrB_2. After treatment with the LISI process, downhole tools can permit higher flow rates of streams that previously caused erosion such as gravel slurries or high velocity fluid flows.

[0014] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

I claim:

1. A tool for use in erosive service downhole comprising a surface in contact with an erosive stream that is made more durable by an application of a precursor laser melted onto the surface.

2. The tool of claim **1**, wherein said surface comprises a part of a cross-over tool, a choke, a frac nipple, a seal bore, a washout tool, or other down-hole orifice where fluid flow erodes the orifice.

3. The tool of claim **1**, wherein said precursor comprises at least one of oxides, ceramics, nanoparticles, nitrides, silicides, and metals, such as: CrB_2, Cr_3C_2, TiB2, Nb_2C, TiC, B_4C, SiC, Mo_2C, SiC, ZrB_2, WC, WZrC, MoB, TiB_2 or CrB_2.

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