IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Title: DOWNHOLE TOOLS WITH PROGRESSIVE CAVITY SECTIONS, AND RELATED METHODS OF USE AND ASSEMBLY

AMENDMENT AFTER NON-FINAL REJECTION

December 01, 2019

TO THE COMMISSIONER FOR PATENTS:

INTRODUCTORY COMMENTS

In response to the office action dated May 30, 2019, Applicant requests a three month extension of time and asks that the patent office please amend the above identified application as follows:

Amendments to the Claims are reflected in the listing of the claims, which begins on page 2 of this paper.

Remarks/Arguments begin on page 7 of this paper.

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A downhole tool comprising:

a progressive cavity section with a stator and a rotor; [[and]]

in which the stator is formed from a single integral block of material, and the stator has a length of at least fifty inches defined between axial ends of the stator;

in which rotor contacting surfaces of the stator, and stator contacting surfaces of the rotor, are rigid and do not flex when in use at downhole temperatures;

in which the stator contacting surfaces and the rotor contacting surfaces are made of metal;

in which the stator is formed by electrochemical machining (ECM) to structure the rotor contacting surfaces of the stator to achieve a sufficiently narrow clearance or negative interference

fit with the rotor to form an efficient pumping seal without seizing the progressive cavity section in use; and

in which the rotor contacting surfaces of the stator have been heat treated for increased surface hardness.

2-4. (Cancelled)

5. (Original) The downhole tool of claim 1 in which the progressive cavity section is connected to rotate a reamer part of a casing reamer shoe.

6. (Original) The downhole tool of claim 1 in which the progressive cavity section is connected to rotate a drill bit.

7. (Original) The downhole tool of claim 1 in which the stator has a length of at least eighty inches defined between axial ends of the stator.

8. (Original) The downhole tool of claim 7 in which the stator has a length of at least one hundred and fifty inches defined between axial ends of the stator.

9. (Original) The downhole tool of claim 8 in which the stator has a length of at least three hundred inches defined between axial ends of the stator.

10. (Currently amended) The downhole tool of claim 1 in which the ~~stator,~~ rotor~~, or both the stator and the rotor are~~ is formed by electrochemical machining (ECM).

11. (Original) A method comprising:

positioning the downhole tool of claim 1 in a well; and

pumping fluid to operate the progressive cavity section to rotate the rotor relative to the stator.

12. (Currently amended) A method comprising:

forming a stator from a single integral block of material, in which the stator has a length of at least fifty inches defined between axial ends of the stator; [[and]]

assembling a downhole tool by inserting a rotor into the stator;

in which rotor contacting surfaces of the stator, and stator contacting surfaces of the rotor, are rigid and do not flex when in use at downhole temperatures;

in which the stator contacting surfaces and the rotor contacting surfaces are made of metal;

in which the stator is formed by electrochemical machining (ECM) to structure the rotor contacting surfaces of the stator to achieve a sufficiently narrow clearance or negative interference

fit with the rotor to form an efficient pumping seal without seizing the progressive cavity section in use; and

in which forming comprises heat treating the rotor contacting surfaces of the stator to increase surface hardness.

13-15. (Cancelled)

16. (Original) The method of claim 12 in which the stator and the rotor within the downhole tool form a progressive cavity power section connected to rotate a reamer part of a casing reamer shoe.

17. (Original) The method of claim 12 in which the stator and the rotor within the downhole tool form a progressive cavity power section connected to rotate a drill bit.

18. (Original) The method of claim 12 in which the stator has a length of at least eighty inches defined between axial ends of the stator.

19. (Original) The method of claim 18 in which the stator has a length of at least one hundred and fifty inches defined between axial ends of the stator.

20. (Original) The method of claim 19 in which the stator has a length of at least three hundred inches defined between axial ends of the stator.

21. (Currently amended) The method of claim 12 in which the ~~stator,~~ rotor~~, or both the stator and the rotor are~~ is formed by electrochemical machining (ECM).

22. (New) The downhole tool of claim 1 in which the stator contacting surfaces of the rotor have been heat treated for increased surface hardness.

23. (New) The downhole tool of claim 1 in which the rotor contacting surfaces of the stator and the stator contacting surfaces of the rotor have been heat treated with nitriding for increased surface hardness.

24. (New) The method of claim 12 in which the stator contacting surfaces of the rotor have been heat treated to increase surface hardness.

25. (New) The method of claim 12 in which the rotor contacting surfaces of the stator and the stator contacting surfaces of the rotor have been heat treated with nitriding to increase surface hardness.

REMARKS

This amendment is responsive to the Office Action mailed May 30, 2019. Applicants have carefully considered the cited art and the comments provided in the Office Action. As will be discussed below, Claims 2-4 and 13-15 are presently canceled without prejudice or disclaimer, and new Claims 22-25 have been added. Accordingly, Claims 1, 5-12, and 16-25 are now pending in the application. Applicants respectfully request reconsideration of the application in view of the foregoing amendments and the following remarks.

Amendments to the Claims

Claim 1 is amended as follows:

- to incorporate features from previous Claims 2-3, which are cancelled, and Claim 10, which is amended accordingly;
- to clarify what is meant by the term rigid and to describe the structure of the rotor contacting surfaces in terms of clearance and negative interference fit, as supported by the application as filed, for example para. 101; and
- to clarify that the rotor contacting surfaces of the stator are heat treated for increased surface hardness as supported by the application as filed, for example para. 165.

The amendments to Claim 1 necessitated the cancellation of claim 4.

Analogous amendments are made to Claim 12, necessitating the cancellation of previous Claims 13-15 and the amendment of claim 21.

New Claims 22 and 24 are added to clarify that the stator contacting surfaces of the rotor are also heat treated to increase surface hardness as supported by the application as filed, for example para. 165.

New Claims 23 and 25 are added to clarify that the rotor contacting surfaces of the stator and the stator contacting surfaces of the rotor have been heat treated with nitriding to increase surface hardness, as supported by the application as filed, for example para. 165.

Information Disclosure Statement

An information disclosure statement is being filed concurrently with this response.

Claim Rejections Under 35 U.S.C. § 112

The Office Action indicated that:

> 2. Claim 11 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.
>
> Claim 11 claims both apparatus (because it depends on claim 1 which is an apparatus claim) and the method steps of using the apparatus is indefinite (refer to MPEP 2173.05(p) II.).

The Applicant respectfully traverses this rejection. Claim 11 is clearly a method claim, as recited in the preamble of Claim 11, and thus is a method of using the downhole tool of Claim 1. Claim 11 is thus definite, and the withdrawal of the claim rejection under Section 112 is respectfully requested.

Patentability of Claims over Underwood in view of Lievestro

The Office Action indicated that:

> 4. Claims 1-4, 6-15, and 17-21 are rejected under 35 U.S.C. 103 as being unpatentable over US 2011/0243774 to Underwood, and further in view of US 7,192,260 to Lievestro.

The Applicant respectfully traverses this rejection.

Applicant's Claim 1 recites:

> A downhole tool comprising:
> a progressive cavity section with a stator and a rotor;
> in which the stator is formed from a single integral block of material, and the stator has a length of at least fifty inches defined between axial ends of the stator;
> in which rotor contacting surfaces of the stator, and stator contacting surfaces of the rotor, are rigid and do not flex when in use at downhole temperatures;
> in which the stator contacting surfaces and the rotor contacting surfaces are made of metal;
> in which the stator is formed by electrochemical machining (ECM) to structure the rotor contacting surfaces of the stator to achieve a sufficiently narrow

clearance or negative interference fit with the rotor to form an efficient pumping seal without seizing the progressive cavity section in use; and

in which the rotor contacting surfaces of the stator are heat treated for increased surface hardness.

Neither Underwood, nor Lievestro teach or suggest Applicant's Claimed structure.

Underwood and Lievestro both fail to teach or suggest at least "rotor contacting surfaces of the stator, and stator contacting surfaces of the rotor, are rigid and do not flex when in use at downhole temperatures", "the stator contacting surfaces and the rotor contacting surfaces are made of metal", "the stator is formed by electrochemical machining (ECM) to structure the rotor contacting surfaces of the stator to achieve a sufficiently narrow clearance or negative interference fit with the rotor to form an efficient pumping seal without seizing the progressive cavity section in use", and "the rotor contacting surfaces of the stator have been heat treated for increased surface hardness".

It is clear from Underwood that in all instances he intends the user to create a finished positive displacement motor that incorporates an elastomeric liner between the rotor and stator. For example, he indicates:

- that "[c]onventional stators commonly include a helical cavity component bonded to an inner surface of a steel tube. The helical cavity component in such conventional stators typically includes an elastomer (e.g., rubber) and provides a resilient surface with which to facilitate the interference fit with the rotor." (para. 4);
- that in some cases "…the helical cavity component is made substantially entirely of a single elastomer layer." (para. 4);
- that prior art stators including a rigid internal helical profile have been developed to have "…a thin elastomer liner is deployed on the inner surface of a rigid, metallic stator former." (para. 6);
- that his stator includes "… a resilient liner 120 deployed on an inner surface of the tube 110" (para. 24);
- that the "…resilient liner 120 defines major and minor internal liner diameters." (para. 26); and

- that the resilient liner "resilient (e.g., elastomer) liner may be formed on the internal helical surface… using conventional injection molding techniques." (para. 30).

Contrary to the Office Action's suggestion otherwise, Underwood describing the resilient liner using the word "may" does not suggest that in some cases the final motor would lack a resilient liner. Underwood's entire background information section and the references above indicate that to the writer a resilient liner is explicitly and implicitly required in the finished product. As far as Underwood describes a manufacturing process, or a stator on its own, his resilient liner could be said to be optional in the sense that Underwood intends to capture a situation of partial stator manufacturing or assembly prior to application of the resilient liner. However, the user in all cases would understand that the finished motor with rotor and stator assembled would require a resilient liner.

Lievestro echoes the requirement of a resilient liner, indicating that "[b]ecause of the requirement for an interference fit between the rotor and stator, one or both of these components must be covered with a resilient, or dimensionally forgiving, material..." (1:37-43). Lievestro further teaches away from a smooth metal to metal contact between rotor and stator by requiring a roughened interior surface of his stator (claim 1 - the rough surface permits a resilient liner to be applied).

Applicant's claimed downhole tool is advantageous over Underwood and Lievestro's tools. By providing a heat-treated, metal to metal seal between rotor and stator, using a stator formed by ECM and structured to achieve a sufficiently narrow clearance or negative interference fit with the rotor to form an efficient pumping seal without seizing the progressive cavity section in use, Applicant has produced an effective progressive cavity section in a downhole tool. Rubberless / metal on metal embodiments of the progressive cavity sections may be used in high temperature downhole applications, where a resilient liner would otherwise degrade (para. 139). ECM is also leveraged to create relatively long and structurally sound stators from single integral blocks of material, with smooth finishes suitable for forming the requisite seal required by the progressive cavity section. Neither Underwood nor Lievestro teach or suggest the claimed structure of the Applicant's downhole tool nor the associated advantages.

Thus, Applicant's Claim 1, and all claims dependent on Claim 1, are patentable over Underwood in view of Lievestro.

For similar reasons, Applicant's Claims 11 and 12, and all claims dependent on such claims, are patentable over Underwood in view of Lievestro.

The Office Action also indicated that:

> 5. Claims 5 and 16 are rejected under 35 U.S.C. 103 as being unpatentable over Underwood in view of Lievestro, and further in view of US 2016/0168912 to Mitchell.

Applicant respectfully traverses this rejection. As above, Applicant's claimed invention is patentable over Underwood in view of Lievestro. Mitchell fails to make up the deficiency in Underwood in view of Lievestro. Thus, Applicant's Claims 1 and 12, and all claims dependent on Claims 1 or 12, are patentable over Underwood in view of Lievestro, and further in view of Mitchell.

CONCLUSION

All pending claims are in condition for allowance. Therefore applicant respectfully requests reconsideration and withdrawal of the objections and rejections, and allowance of the claims, at an early date. Should any issues remain needing resolution prior to allowance, the Examiner is requested to contact applicant's undersigned representative at the telephone number indicated below.

December 2, 2019

Respectfully submitted,

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