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(54) **MINIMAL COOLANT MICRO-FINISHING SYSTEM AND PROCESS**

(57) The present disclosure relates generally to the field of surface finishing operations, more particularly to micro-finishing systems and processes. The micro-finishing system and process of the present disclosure is configured to perform surface finishing operation on a work-piece. The micro-finishing system comprises: (i) a micro-finishing film having a layer of abrasives which is configured to be rubbed against the work-piece, (ii) a

contact tooling which is configured to provide support to the micro-finishing film, and (iii) ports which are configured within the contact tooling strategically to reduce heat and frictional losses generated due to rubbing of the layer of abrasives against the work-piece by a minimum flow of coolant at the desired location. The ports are typically drilled holes.

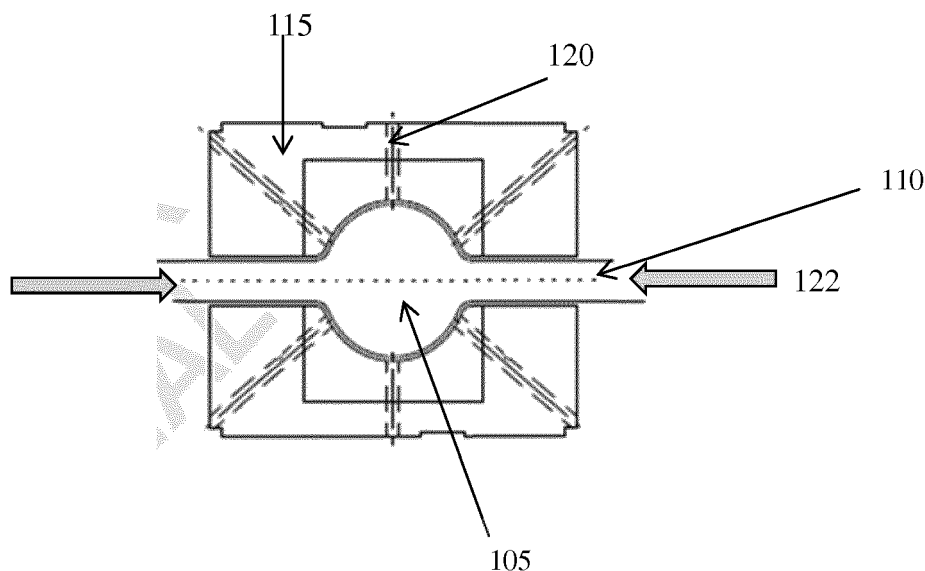


FIGURE 1

DescriptionFIELD

- 5 **[0001]** The present disclosure relates generally to the field of surface finishing operations, more particularly to micro-finishing process.

DEFINITION

- 10 **[0002]** The term "Micro-finishing" hereinafter in the specification will refer to a metalworking process that improves surface finish of a work-piece, which creates a cross-hatch pattern on the work-piece.

BACKGROUND

- 15 **[0003]** Micro-finishing operation is typically required on several industrial work-pieces, technically known as work-pieces, such as Camshaft Lobes, Crankshaft Pins etc., either partially or completely. The micro-finishing operation is generally executed in wet condition in presence of a coolant for facilitating cleaning of a micro-finishing film which gets clogged with fine chips, and for cooling the work-piece on which the micro-finishing took place.

- 20 **[0004]** Conventionally, micro-finishing operation includes micro-finishing film and contact tooling which enclose a work-piece on which surface finishing is to be achieved. The coolant is provided on the work-piece in breaks or continuously for cleaning and cooling purpose. However, in conventional micro-finishing operation, the coolant is not provided in the enclosed region where it is actually required. Also, the coolant flow is kept high due to this inefficiency. Moreover, since the coolant is not provided in the enclosed region, the film consumption is more due to improper cleaning of the film.

- 25 **[0005]** Conventionally, minimal coolant systems have also been developed in machining operations such as drilling which uses ported drilling tools and mist lubrication for cleaning and cooling purpose, however because the tools are so different, the same technology doesn't apply to micro-finishing process.

- [0006]** Hence, there is a need for developing a micro-finishing system and a process for achieving Minimal Coolant Flow Rate while improving life and performance of the micro-finishing film by continuously cleaning of the film.

30 OBJECTS

- [0007]** Some of the objects of the present disclosure are aimed to ameliorate one or more problems of the prior art or to at least provide a useful alternative and are listed herein below.

- 35 **[0008]** An object of the present disclosure is to provide a micro-finishing system and a process for achieving minimal coolant flow rate while improving life and performance of the micro-finishing film by continuous cleaning of the film.

- [0009]** Another object of the present disclosure is to provide a micro-finishing system and process that reduces the coolant flow, energy consumption, machine footprint, and disposal of coolant.

- [0010]** Another object of the present disclosure is to provide a micro-finishing system and process that enhances coolant management and reduces machine area required for the activity.

- 40 **[0011]** Yet another object of the present disclosure is to provide a micro-finishing system and process that reduces the per work-piece cost for surface finishing.

- [0012]** Yet another object of the present disclosure is to provide a micro-finishing system and process that fastens the processing due to cleaner film.

- 45 **[0013]** Other objects and advantages of the present disclosure will be more apparent from the following description when read in conjunction with the accompanying figures, which are not intended to limit the scope of the present disclosure.

SUMMARY

- 50 **[0014]** The present disclosure envisages a micro-finishing system for performing a surface finishing operation on a work-piece at a desired location. The micro-finishing system comprises:

- (i) a micro-finishing film having a layer of abrasives which is configured to be rubbed against the work-piece at the desired location,
- (ii) a contact tooling which is configured to provide support to the micro-finishing film, and
- 55 (iii) ports which are configured on the contact tooling for providing a flow of coolant at the desired location for reducing heat and frictional losses generated due to rubbing of the layer of abrasives against the work-piece. The ports are typically drilled holes.

[0015] In an embodiment of the present disclosure, the layer of abrasives of the micro-finishing system has perforations which allow coolant flow towards the work-piece from the ports of the contact tooling. In another embodiment, the perforations of the layer of abrasives are configured to have different patterns and have any regular or irregular geometrical shape.

[0016] In another embodiment of the present disclosure, the layer of abrasives of the micro-finishing system is in the form of a film, a tape, or a belt. Further, the rubbing of the layer of abrasives against the work-piece may be configured to remove a thin amorphous surface layer of the work-piece. In yet another embodiment, the layer of abrasives is indexed periodically and the work-piece is rotated and oscillated which causes the cross-hatching at the desired location.

[0017] The present disclosure also envisages a process for performing a micro-finishing operation on a surface of a work-piece at the desired location by means of a micro-finishing film. The micro-finishing process comprises the following steps:

- (i) supporting the micro-finishing film with a contact tooling,
- (ii) providing a layer of abrasives on the micro-finishing film,
- (iii) rubbing the layer of abrasives against the work-piece,
- (iv) configuring ports on the contact tooling, and
- (v) supplying coolant at the desired location for reducing frictional losses generated due to rubbing of the layer of abrasives against the work-piece. The micro-finishing process further comprises the steps of periodic indexing of the layer of abrasives and rotation and oscillation of the work-piece against the layer of abrasives to cause cross-hatching at the desired location.

BRIEF DESCRIPTION OF ACCOMPANYING DRAWING

[0018] A micro-finishing system and process, of the present disclosure will now be described with the help of accompanying drawing, in which:

- Fig. 1 illustrates a schematic view of the micro-finishing system, according to an embodiment of the present disclosure; and
- Fig. 2 illustrates a sectional view of abrasives used in the micro-finishing system and process, in accordance with an exemplary embodiment of the present disclosure.

LIST OF REFERENCE NUMERALS

Reference numeral	References associated with reference numeral
100	Micro-finishing System
105	Work-Piece
110	A Layer of Abrasives
112	Perforations
115	Contact Tooling
120	Ports
122	Coolant Flow

DETAILED DESCRIPTION

[0019] Micro-finishing operation is typically required on several industrial work-pieces such as Camshaft Lobes, Crankshaft Pins etc., either partially or completely. The micro-finishing operation is typically done in wet condition in the presence of a coolant for facilitating cleaning of micro-finishing film which gets clogged with fine chips, and for cooling the work-piece during operation.

[0020] Conventionally, micro-finishing operation includes micro-finishing film and contact tooling which enclose the work-piece/product on which surface finishing is done. The coolant is provided on the work-piece in breaks or continually for cleaning and cooling purpose. However, in conventional micro-finishing operation, the coolant is not provided in the enclosed region where it is actually required. Also, the coolant flow is kept high due to this inefficiency. Moreover, since the coolant is not provided in the enclosed region, the film consumption is more due to improper cleaning of the film.

[0021] Conventionally, Minimal Coolant Systems have also been developed in Machining Operations such as Drilling

which use Ported Drilling Tools and Mist Lubrication for cleaning and cooling purpose, however the same technology has been found ineffective in case of micro-finishing process.

[0022] The present disclosure envisages a micro-finishing system and process that overcomes or alleviates the above-mentioned drawbacks. The micro-finishing system and process, in accordance with an embodiment of the present disclosure will now be described with reference to the embodiments, which do not limit the scope and ambit of the disclosure. The description of the micro-finishing system and process is provided purely by way of example and illustration.

[0023] Figure 1 illustrates a schematic view of a micro-finishing system and process 100, according to an embodiment of the present disclosure. Figure 2 illustrates a sectional view of a layer of abrasives 110 used in the micro-finishing system and process 100, in accordance with an exemplary embodiment of the present disclosure.

[0024] The micro-finishing system and process 100 disclosed in the present disclosure teaches micro-finishing on a surface of work-pieces for achieving minimal coolant flow rate and improving the life of a micro-finishing film (not labelled in the figures) and performance, by providing continuous cleaning of the micro-finishing film. The micro-finishing system and process of the present disclosure uses a ported contact tooling and the perforated layer of abrasives for micro-finishing application to achieve minimal coolant flow rate. Micro-finishing is typically a metalworking process that improves surface finish, which is achieved by removing just the thin amorphous surface layer by the means of abrasives.

[0025] The micro-finishing system and process 100, as illustrated in Figure 1 of the present disclosure, comprises a micro-finishing film, a work-piece 105 on which surface finishing is to be performed at a desired location, a layer of abrasives 110, a contact tooling 115, and ports 120 configured on the contact tooling 115.

[0026] The layer of abrasives 110 is configured to be rubbed against the work-piece 105. In an embodiment, the layer of abrasives 110 is configured to have perforations 112. In another embodiment, the layer of abrasives 110 can be in the form of a film, a tape, or a belt. In an operative configuration, an indexing means is provided to periodically index the layer of abrasives 110 that is the abrasive film/tape/belt, while another means is provided to rotate or oscillate the work-piece 105 against the layer of adhesives 110 causing the cross-hatching at the desired location. In an embodiment, sometimes to generate a "straight line" finish the work-piece is not oscillated.

[0027] The contact tooling 115 is configured to provide support to the micro-finishing film. The ports 120 are configured strategically on the contact tooling 115 for supplying minimum flow of coolant at the desired location for reducing heat and frictional losses generated due to rubbing of the layer of abrasives 110 against the work-piece 105. In an embodiment, the ports 120 are typically drilled holes.

[0028] The unique feature of the micro-finishing system 100 of the present disclosure is ported contact tooling 115. In an embodiment, the ports 120 in tooling allow coolant to flow 122 through the tooling towards the work-piece 105. In an embodiment, the ports 120 are typically drilled holes but can also be of any other type. Another unique feature of the micro-finishing system 100 of the present disclosure is the perforated layer of abrasives 110. The perforations 112 in the layer of abrasives 110 allow coolant from the ports 120 to reach the abrasives and the work-piece 105 which is being processed. In an embodiment, the perforations 112 configured on the abrasives can have different patterns and have any regular or irregular geometrical shape, and are not limited to what is illustrated in Figure 2.

[0029] The present disclosure also envisages a micro-finishing process for performing a surface finishing operation on a work-piece at a desired location by means of a micro-finishing film. The micro-finishing process comprises the following steps:

- (i) supporting the micro-finishing film with a contact tooling,
- (ii) providing a layer of abrasives on the micro-finishing film,
- (iii) rubbing the layer of abrasives against the work-piece at the desired location, and
- (iv) configuring ports on the contact tooling strategically to facilitate flow of coolant at the desired location for reducing frictional losses generated due to rubbing of the layer of abrasives against the work-piece.

[0030] Advantages of the micro-finishing system/process 100 are:

- (i) it reduces the required amount of coolant flow,
- (ii) it reduces energy consumption required by pump,
- (iii) it reduces machine (computer) footprint,
- (iv) it reduces coolant disposal,
- (v) it increase the Micro-finishing Film Life,
- (vi) it reduces the per piece cost of micro-finishing,
- (vii) it increases the productivity of the machine, and
- (viii) it increases the processing speed due to cleaner film. In an embodiment, the micro-finishing system/process 100 can be used in all micro-finishing machines.

TECHNICAL ADVANCEMENTS AND ECONOMICAL SIGNIFICANCE

[0031] The micro-finishing system/process, in accordance with the present disclosure described herein above has several technical and economic advantages including but not limited to providing a system/process that:

- achieves Minimal Coolant Flow Rate and improves Micro-finishing Film Life and Performance due to consistent cleaning of the film;
- reduces the coolant flow, energy consumption, reduces machine footprint, and disposal of coolant;
- enhances coolant management and reduces machine area required for the activity;
- reduces the per piece cost for surface finishing; and
- fastens the processing due to cleaner film.

[0032] Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

[0033] The use of the expression "at least" or "at least one" suggests the use of one or more elements or mixtures or quantities, as the use may be in the embodiment of the disclosure to achieve one or more of the desired objects or results.

[0034] Any discussion of documents, acts, materials, devices, articles or the like that has been included in this specification is solely for the purpose of providing a context for the disclosure. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the disclosure, as it existed anywhere before the priority date of this application.

[0035] The systems and methods are not limited to the specific embodiments described herein. In addition, work-pieces of each system and each method can be practiced independently and separately from other work-pieces and methods described herein. Each work-piece and method can be used in combination with other work-pieces and other methods.

[0036] While considerable emphasis has been placed herein on the specific features of the preferred embodiment, it will be appreciated that many additional features can be added and that many changes can be made in the preferred embodiment without departing from the principles of the invention. These and other changes in the preferred embodiment of the invention will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the invention and not as a limitation.

[0037] The embodiments herein and the various features and advantageous details thereof are explained with reference to the non-limiting embodiments in the following description. Descriptions of well-known work-pieces and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein.

[0038] Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

Claims

1. A micro-finishing system (100) for performing a surface finishing operation on a desired location on a work-piece (105), **characterized in that** said micro-finishing system (100) comprises:

- a micro-finishing film having a layer of abrasives (110) configured to be rubbed against said work-piece (105) at the desired location;
- a contact tooling (115) configured to provide support to said micro-finishing film; and
- ports (120) configured within said contact tooling (115) for providing a flow of coolant at the desired location for strategically reducing heat and frictional losses generated due to rubbing of said layer of abrasives (110) against said work-piece (105).

2. The micro-finishing system (100) as claimed in claim 1, wherein said layer of abrasives (110) has perforations (112) which allow the coolant flow (122) towards said work-piece (105) from said ports (120) of said contact tooling (115).

3. The micro-finishing system (100) as claimed in claim 2, wherein said perforations (112) are configured to have different patterns and have any regular or irregular geometrical shape.

4. The micro-finishing system (100) as claimed in claim 1, wherein said layer of abrasives (110) is in the form of a film,

a tape, or a belt.

- 5 5. The micro-finishing system (100) as claimed in claim 1, wherein said rubbing of said layer of abrasives (110) against said work-piece (105) is configured to remove a thin amorphous surface layer of said work-piece (105).
- 6 6. The micro-finishing system (100) as claimed in claim 1, which includes an indexing means configured to periodically index said layer of abrasives (110).
- 10 7. The micro-finishing system (100) as claimed in claim 1, which includes a means configured to rotate and oscillate said work-piece (105) against said layer of abrasives (110) causing the cross-hatching at the desired location.
- 8 8. The micro-finishing system (100) as claimed in claim 1, wherein said ports (120) are typically drilled holes.
- 15 9. A process for performing a micro-finishing operation on the surface of a work-piece at a desired location by means of a micro-finishing film, said micro-finishing process comprising the following steps:
 - supporting said micro-finishing film with a contact tooling;
 - providing a layer of abrasives on said micro-finishing film;
 - rubbing said layer of abrasives against said work-piece;
 - 20 • configuring ports on said contact tooling; and
 - supplying coolant at the desired location for reducing frictional losses generated due to rubbing of said layer of abrasives against said work-piece.
- 25 10. The micro-finishing process as claimed in claim 9 which further comprises the step of indexing said layer of abrasives periodically.
- 30 11. The micro-finishing process as claimed in claim 9 which further comprises the step of rotating and oscillating said work-piece against said layer of abrasives to cause cross-hatching at the desired location.

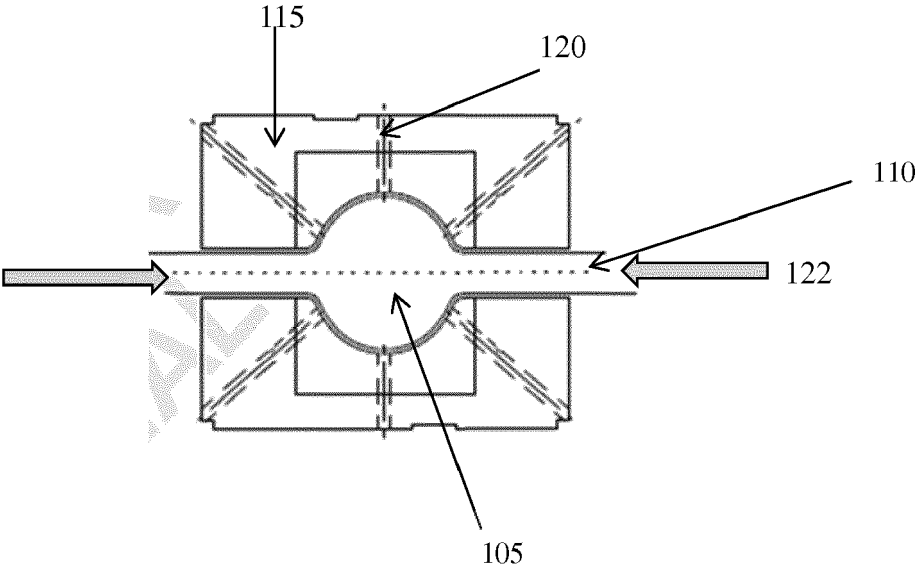


FIGURE 1

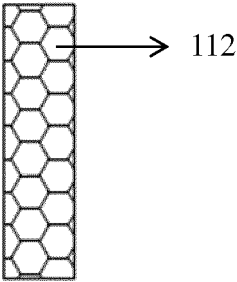


FIGURE 2



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 3420

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 682 444 A (JUDGE NORMAN R [US] ET AL) 28 July 1987 (1987-07-28) * column 7, line 47 - column 7, line 57; figure 11 * * column 4, line 1 - column 6, line 40; figure 4 *	1-11	INV. B24B19/12 B24B21/02 B24B35/00 B24B55/02 B24B5/42 B24D3/00
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			TECHNICAL FIELDS SEARCHED (IPC)
			B24B B24D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 December 2017	Examiner Watson, Stephanie
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 17 3420

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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18-12-2017

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