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Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-bis)

945273

**THE UNITED STATES OF AMERICA**

**TO ALL TO WHOM THESE PRESENTS SHALL COME:**

**UNITED STATES DEPARTMENT OF COMMERCE**

**United States Patent and Trademark Office**

*August 25, 2018*

**THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.**

**APPLICATION NUMBER: 62/543,305**

**FILING DATE: August 09, 2017**

**RELATED PCT APPLICATION NUMBER: PCT/US18/46104**

**THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US62/543,305**



Certified by

Under Secretary of Commerce  
for Intellectual Property  
and Director of the United States  
Patent and Trademark Office

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<b>Provisional Application for Patent Cover Sheet</b>					
This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)					
<b>Inventor(s)</b>					
Inventor 1					<input type="button" value="Remove"/>
Given Name	Middle Name	Family Name	City	State	Country
Matt		Svrcek	Redwood City	CA	US
All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the <b>Add</b> button.					<input type="button" value="Add"/>
<b>Title of Invention</b>		Piston Seal With Solid Lubricant Applicator			
Attorney Docket Number (if applicable)		EG-020 PROV			
<b>Correspondence Address</b>					
Direct all correspondence to (select one):					
<input checked="" type="radio"/> The address corresponding to Customer Number			<input type="radio"/> Firm or Individual Name		
Customer Number			15314		

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.	
<input checked="" type="radio"/> No.	
<input type="radio"/> Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:	
<input type="radio"/> Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:	

**Entity Status**

**Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29**

- Applicant asserts small entity status under 37 CFR 1.27
- Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- No

**Warning**

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

**Signature**

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Alexander Shvarts/			Date (YYYY-MM-DD)	2017-08-09
First Name	Alexander	Last Name	Shvarts	Registration Number (If appropriate)	47943

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

## Privacy Act Statement

**The Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that : (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	EG-020 PROV
		Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

### Secrecy Order 37 CFR 5.2:

Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

### Inventor Information:

<b>Inventor 1</b>					
<b>Legal Name</b>					
<b>Prefix</b>	<b>Given Name</b>	<b>Middle Name</b>	<b>Family Name</b>	<b>Suffix</b>	
	Matt		Svrcek		
<b>Residence Information (Select One)</b> <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service					
<b>City</b>	Redwood City	<b>State/Province</b>	CA	<b>Country of Residence <sup>i</sup></b>	US
<b>Mailing Address of Inventor:</b>					
<b>Address 1</b>	163 Santiago Avenue				
<b>Address 2</b>					
<b>City</b>	Redwood City	<b>State/Province</b>	CA		
<b>Postal Code</b>	94061	<b>Country <sup>i</sup></b>	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the <b>Add</b> button. <span style="float: right;"><input type="button" value="Add"/></span>					

### Correspondence Information:

<b>Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).</b>			
<input type="checkbox"/> An Address is being provided for the correspondence information of this application.			
<b>Customer Number</b>	15314		
<b>Email Address</b>	patents@slpatents.com	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

### Application Information:

<b>Title of the Invention</b>	Piston Seal With Solid Lubricant Applicator		
<b>Attorney Docket Number</b>	EG-020 PROV	<b>Small Entity Status Claimed</b>	<input checked="" type="checkbox"/>
<b>Application Type</b>			
<b>Subject Matter</b>			
<b>Total Number of Drawing Sheets (if any)</b>		<b>Suggested Figure for Publication (if any)</b>	

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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	EG-020 PROV
		Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator		

### Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

### Publication Information:

Request Early Publication (Fee required at time of Request 37 CFR 1.219)

**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

### Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	<input checked="" type="radio"/> Customer Number	<input type="radio"/> US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)		
Customer Number	15314				
Prefix	<b>Given Name</b>	Middle Name	<b>Family Name</b>	Suffix	<input type="button" value="Remove"/>
Registration Number					
Prefix	<b>Given Name</b>	Middle Name	<b>Family Name</b>	Suffix	<input type="button" value="Remove"/>
Registration Number					
Additional Representative Information blocks may be generated within this form by selecting the <b>Add</b> button.					

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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	EG-020 PROV
		Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator		

### Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.  
 When referring to the current application, please leave the application number blank.

Prior Application Status			<input type="button" value="Remove"/>
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the <b>Add</b> button.			

### Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country <sup>i</sup>	Filing Date (YYYY-MM-DD)	Access Code <sup>i</sup> (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the <b>Add</b> button.			

### Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

<input type="checkbox"/>	This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	EG-020 PROV
	Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator	

## Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

**NOTE:** This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

### 1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

**A. Priority Document Exchange (PDX)** - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

**B. Search Results from U.S. Application to EPO** - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

### 2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

**NOTE:** Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>	Attorney Docket Number	EG-020 PROV
	Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator	

## Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

**Applicant 1**

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Assignee     
  Legal Representative under 35 U.S.C. 117     
  Joint Inventor

Person to whom the inventor is obligated to assign.     
  Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here.

Organization Name      EtaGen, Inc.

**Mailing Address Information For Applicant:**

Address 1	186 Constitution Drive		
Address 2			
City	Menlo Park	State/Province	CA
Country <sup>1</sup>	US	Postal Code	94025
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

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<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	EG-020 PROV
		Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator		

### Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
If the Assignee or Non-Applicant Assignee is an Organization check here. <input type="checkbox"/>				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country <sup>i</sup>	Postal Code			
Phone Number		Fax Number		
Email Address				
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>Application Data Sheet 37 CFR 1.76</b>		Attorney Docket Number	EG-020 PROV
		Application Number	
Title of Invention	Piston Seal With Solid Lubricant Applicator		

**Signature:**

**NOTE:** This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

<b>Signature</b>	/Alexander Shvarts/			Date (YYYY-MM-DD)	
<b>First Name</b>	Alexander	<b>Last Name</b>	Shvarts	<b>Registration Number</b>	47943

Additional Signature may be generated within this form by selecting the Add button.

EG-020 PROV

TITLE: Piston Seal With Solid Lubricant Applicator

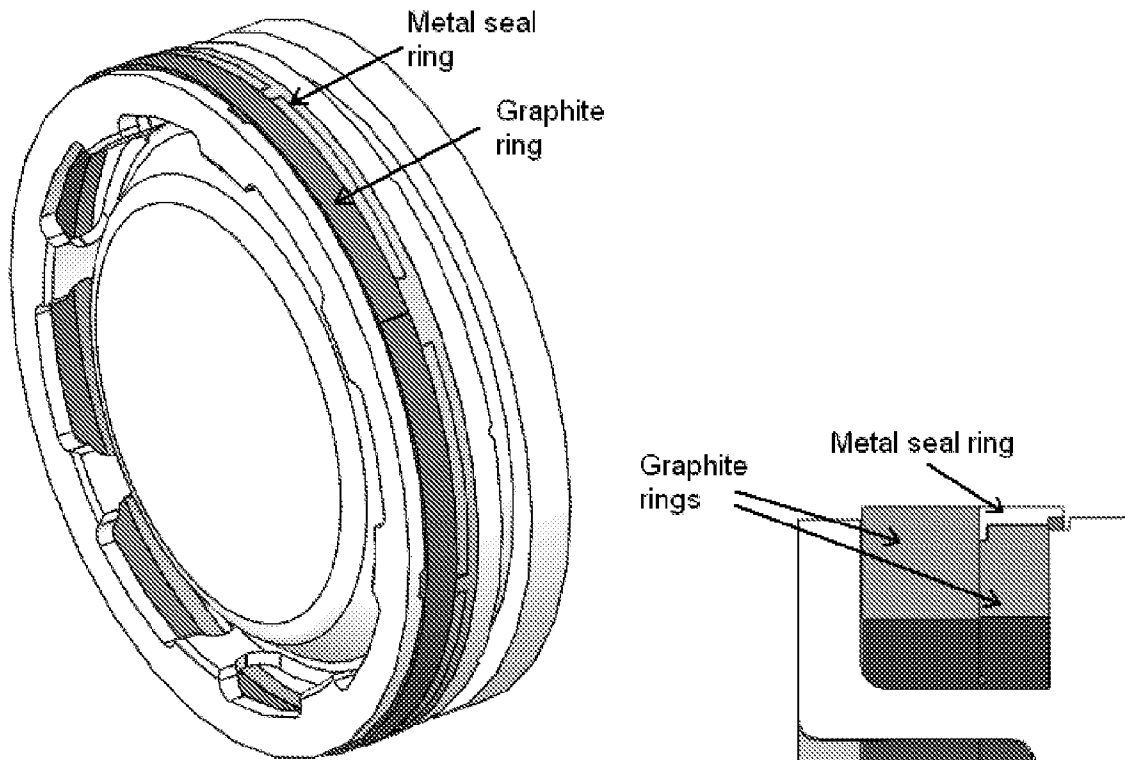
This disclosure relates to the field of sealing a gas in a cylinder, in particular in the absence of a liquid lubricant material (e.g. oil). Provided is a seal assembly mounted on a piston that reciprocates inside of a cylinder. The seal assembly separates high pressure gas on one end of the piston from low pressure gas on the other end.

In some embodiments, the particular seal of the present disclosure includes two or more ring-shaped elements located in one or more grooves in the piston. At least one of the ring elements is constructed from a strong ductile material such as a metal. This metal ring provides the primary sealing function. A split in the metal ring allows it to expand radially outward to match the cylinder bore and maintain a tight seal.

The metal seal ring arrangement described above is well known in the art, and in the presence of oil lubrication performs well with low wear rates and good sealing for acceptable life times. In the absence of lubrication, however, the metal materials described above fail by scuffing, galling, or other damage due to excessive friction and wear between the ring and the cylinder. The present disclosure thus introduces lubricant film to the cylinder from a solid lubricant applicator located on the piston near the seal ring. As the piston reciprocates, this solid-lubricant applicator slides against the cylinder and applies solid lubricant material to the cylinder inner surface. The metal seal ring slides on this film of solid lubricant in the same manner it would have slid on an oil film in the oil-lubricated setting.

In the illustrative figures below, the solid-lubricant applicator includes a second split ring of graphite material located in the groove on the piston. The graphite ring is arranged in the groove such that it is free to move independently from the seal ring, and thus can wear at a different rate from the metal seal. Gas pressure on the inner surface of the graphite ring pushes it outward against the cylinder, causing graphite material to be transferred from the ring to the cylinder wall. The metal seal ring is thus lubricated by the graphite film.

The metal seal element also must seal against the downstream face of the piston groove. As the piston and ring move relative to each other, rubbing wear and friction occur between the metal seal ring and piston groove. In an oil-lubricated setting, oil is present at this interface to reduce friction. In the context of this disclosure, in the absence of oil-lubrication, one solution is to insert solid lubricant material in the interface between the ring and piston groove. In the figures below this is accomplished by a second graphite ring located at the inner surface of the metal seal ring. This inner graphite ring provides an intermediate sliding interface with good wear properties between the metal seal ring and the piston.

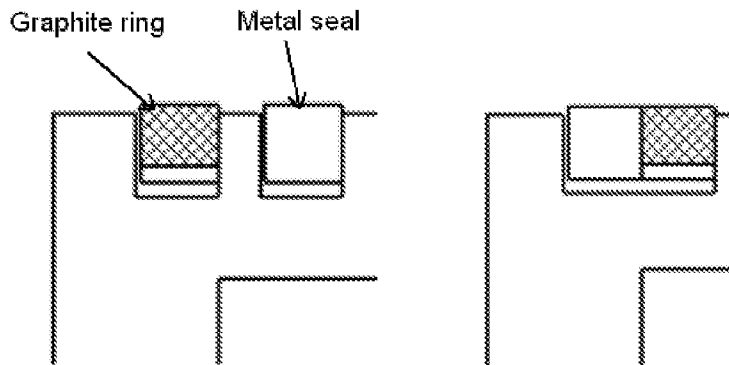


For internal combustion engine applications, a possible solid lubricant material is graphite, including graphite materials that may be impregnated with a minority fraction of another material, such as an oxidation inhibitor. For lower-temperature applications such as compressors, the solid lubricant material can be a polymer such as PTFE, often with graphite embedded. Other solid lubricants are possible as well, including hexagonal boron nitride and molybdenum disulfide.

The metal seal ring could be made of any strong ductile material, such as steel, stainless steel, a copper alloy, a high-temperature alloy such as Inconel or other nickel alloys, etc. A coating or other surface treatment could be applied to this surface for wear resistance, such as a thermal spray coating, a physical vapor deposition coating, various kinds of platings such as chrome, a diamond-like carbon coating, surface treatments such as nitriding or heat treating, or any of the other widely known surface treatments optimized for wear resistance.

While the above discussion refers to a particular layout of the seal ring and solid lubricant applicator, it will be understood that any other suitable arrangements are possible. For example, it may be desirable to have the graphite ring and metal seal ring sit in separate grooves on the piston. In other instances it may be desirable to have the graphite ring sit downstream of the metal seal ring. The lubricant applicator in this configuration also doubles as the low-friction surface on which the metal seal ring rests. These example arrangements are shown below. Many other configurations are possible, with the key distinguishing characteristics being the presence on the piston of a seal ring (e.g., a split seal ring) made of a strong wear-resistant material such as metal or coated metal, and a separate, independently

wearing solid lubricant applicator made of graphite or other solid lubricant material that applies a solid lubricant film to the cylinder as it wears.



It will be understood that the present disclosure is not limited to the embodiments described herein and can be implemented in the context of any suitable system. In some suitable embodiments, the present disclosure is applicable to reciprocating engines and compressors. In some embodiments, the present disclosure is applicable to free-piston engines and compressors. In some embodiments, the present disclosure is applicable to combustion and reaction devices such as a reciprocating engine and a free-piston engine. In some embodiments, the present disclosure is applicable to non-combustion and non-reaction devices such as reciprocating compressors and free-piston compressors. In some embodiments, the present disclosure is applicable to gas springs. In some embodiments, the present disclosure is applicable to oil-free reciprocating and free-piston engines and compressors. In some embodiments, the present disclosure is applicable to oil-free free-piston engines with internal or external combustion or reactions. In some embodiments, the present disclosure is applicable to oil-free free-piston engines that operate with compression ignition, spark ignition, or both. In some embodiments, the present disclosure is applicable to oil-free free-piston engines that operate with gaseous fuels, liquid fuels, or both. In some embodiments, the present disclosure is applicable to linear free-piston engines. In some embodiments, the present disclosure is applicable to engines that can be combustion engines with internal combustion/reaction or any type of heat engine with external heat addition (e.g., from a heat source or external combustion/reaction).

1. A sealing ring arrangement, comprising:
  - a first ring comprising a metal arranged on a piston; and
  - a second ring comprising a solid lubricant arranged on the piston, wherein the second ring lubricates an inside surface of a cylinder as the piston translates within the cylinder, effecting lubrication between the first ring and the inside surface of the cylinder.
2. The sealing ring arrangement of paragraph 1, wherein the first ring and the second ring are arranged within a circumferential groove on the surface of the piston.

3. The sealing ring arrangement of paragraph 1, wherein the first ring and the second ring are arranged within respective circumferential grooves on the surface of the piston.
4. The sealing ring of paragraph 2 or 3, wherein the first ring is axially behind the second ring.
5. The sealing ring of paragraph 2 or 3, wherein the second ring is axially behind the first ring.



## Electronic Acknowledgement Receipt

<b>EFS ID:</b>	30018283
<b>Application Number:</b>	62543305
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	6677
<b>Title of Invention:</b>	Piston Seal With Solid Lubricant Applicator
<b>First Named Inventor/Applicant Name:</b>	Matt Svrcek
<b>Customer Number:</b>	15314
<b>Filer:</b>	Alexander Shvarts/Juanita Alvarez
<b>Filer Authorized By:</b>	Alexander Shvarts
<b>Attorney Docket Number:</b>	EG-020 PROV
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)  
 37 CFR 1.20 (Post Issuance fees)  
 37 CFR 1.21 (Miscellaneous fees and charges)

**File Listing:**

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	EG_020_PROV_Cover_Sheet.pdf	87556	no	3
			a972c2909299dc96aaebd106da301e9e306268e		
<b>Warnings:</b>					
This is not a USPTO supplied Provisional Cover Sheet SB16 form.					
<b>Information:</b>					
2	Application Data Sheet	WebADS.pdf	113827	no	7
			83f72d08e06870663396209c2c43e305faf3fa18		
<b>Warnings:</b>					
<b>Information:</b>					
3	Specification	EG_020_PROV_Disclosure.pdf	357401	no	4
			131c53cd6c7437f33d6f1204cc44dda9a5e9e8b3		
<b>Warnings:</b>					
<b>Information:</b>					
4	Fee Worksheet (SB06)	fee-info.pdf	29758	no	2
			758467a394f8ee6c14f77f2034dc8b09359c9386		
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**New Applications Under 35 U.S.C. 111**

**If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.**

**National Stage of an International Application under 35 U.S.C. 371**

**If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.**

**New International Application Filed with the USPTO as a Receiving Office**

**If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.**