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(54) **HYDRAULIC HAMMER HAVING SINGLE PIECE SEAL ASSEMBLY**

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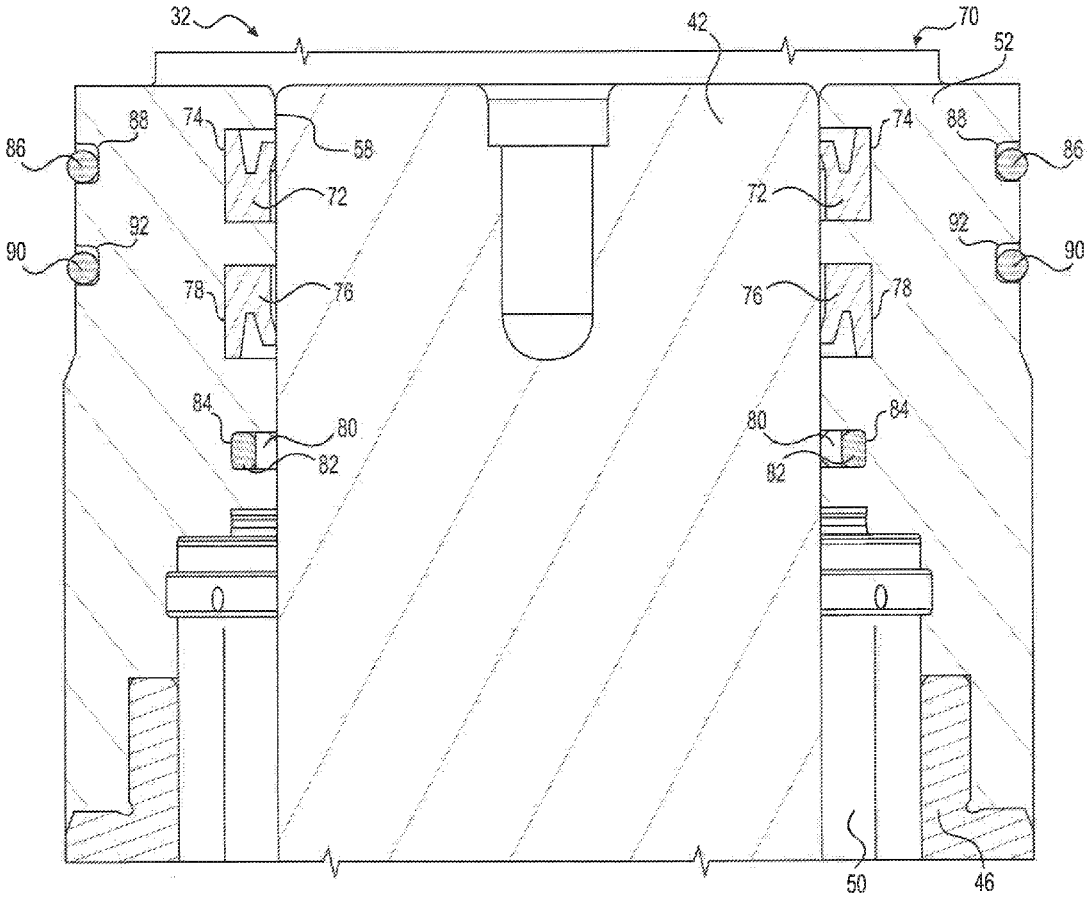
(57) **ABSTRACT**

A seal assembly for a hydraulic hammer is disclosed. The seal assembly may include a seal carrier having at least one annular recess. The seal assembly may also include at least one seal integrally molded onto surfaces of the at least one annular recess.



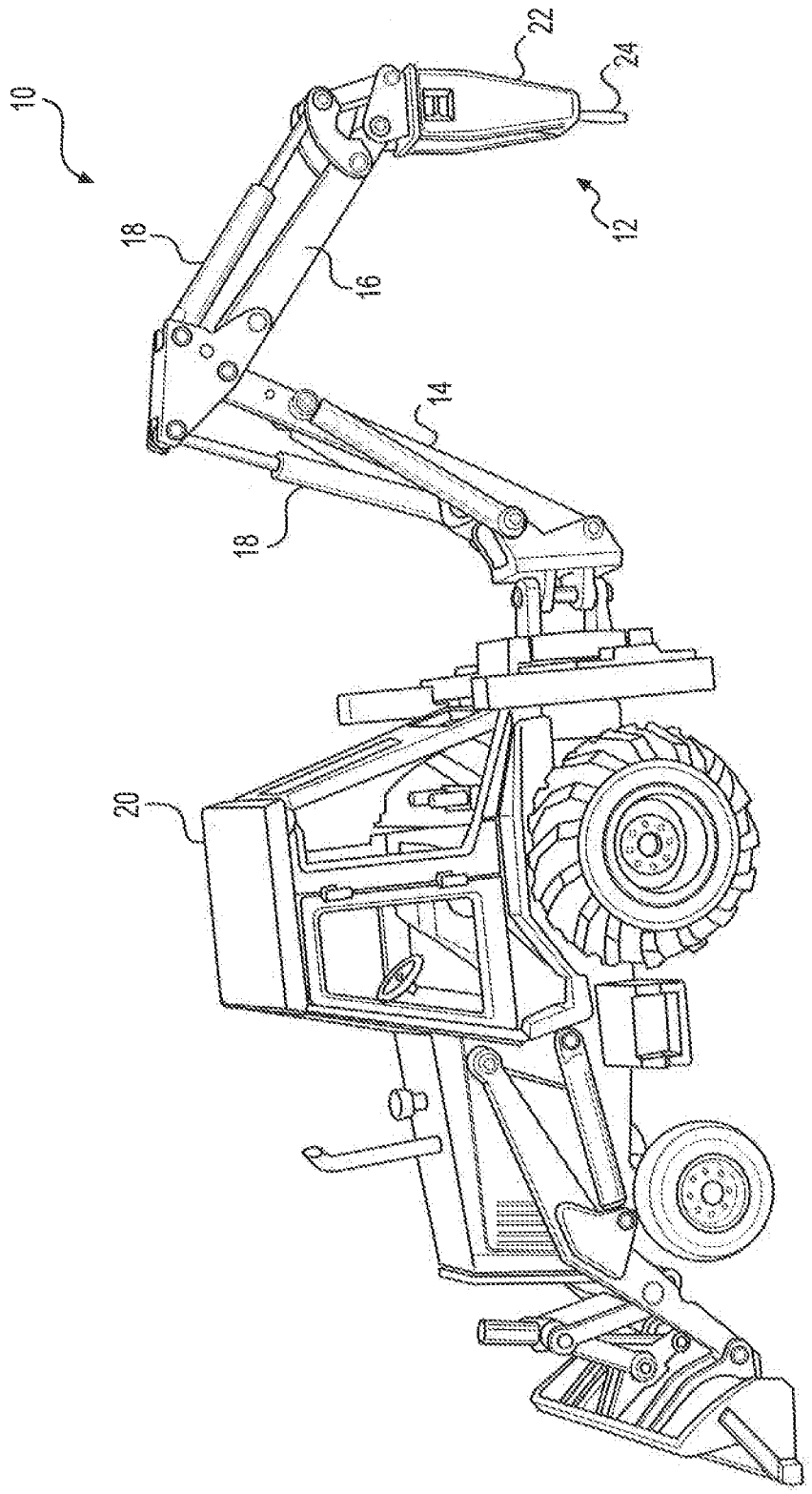


FIG. 1

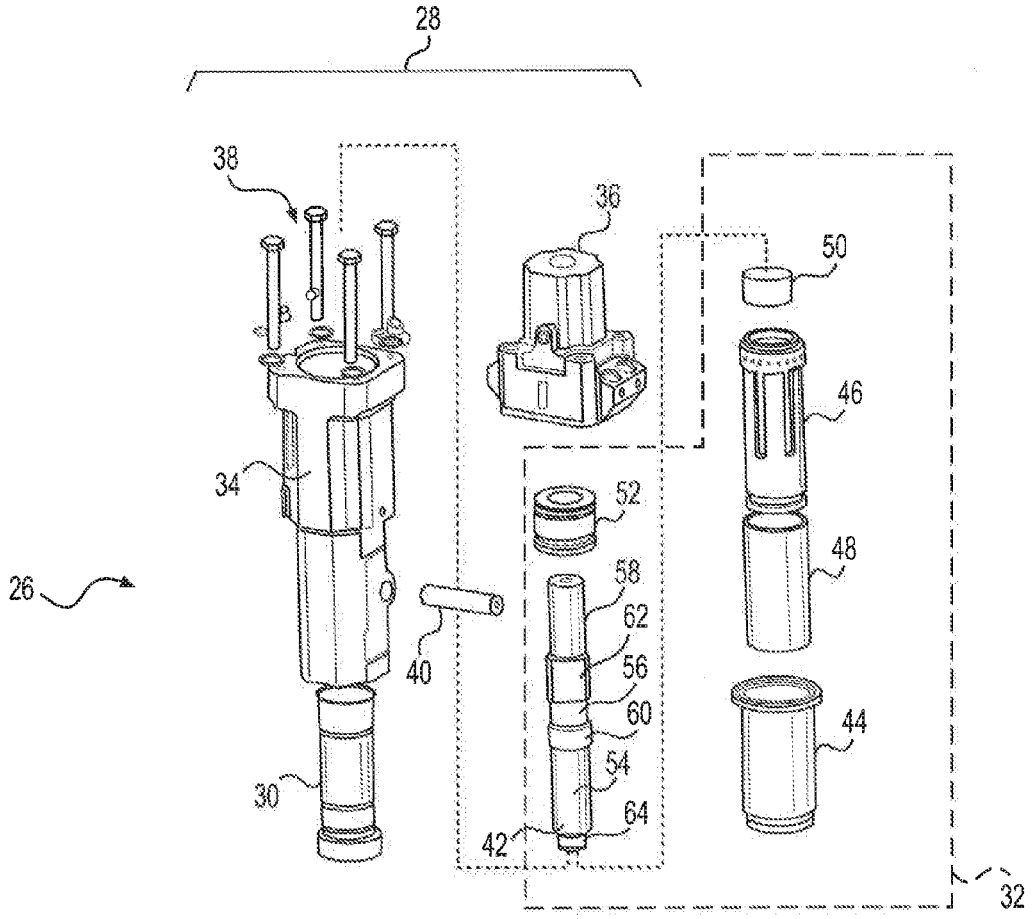


FIG. 2

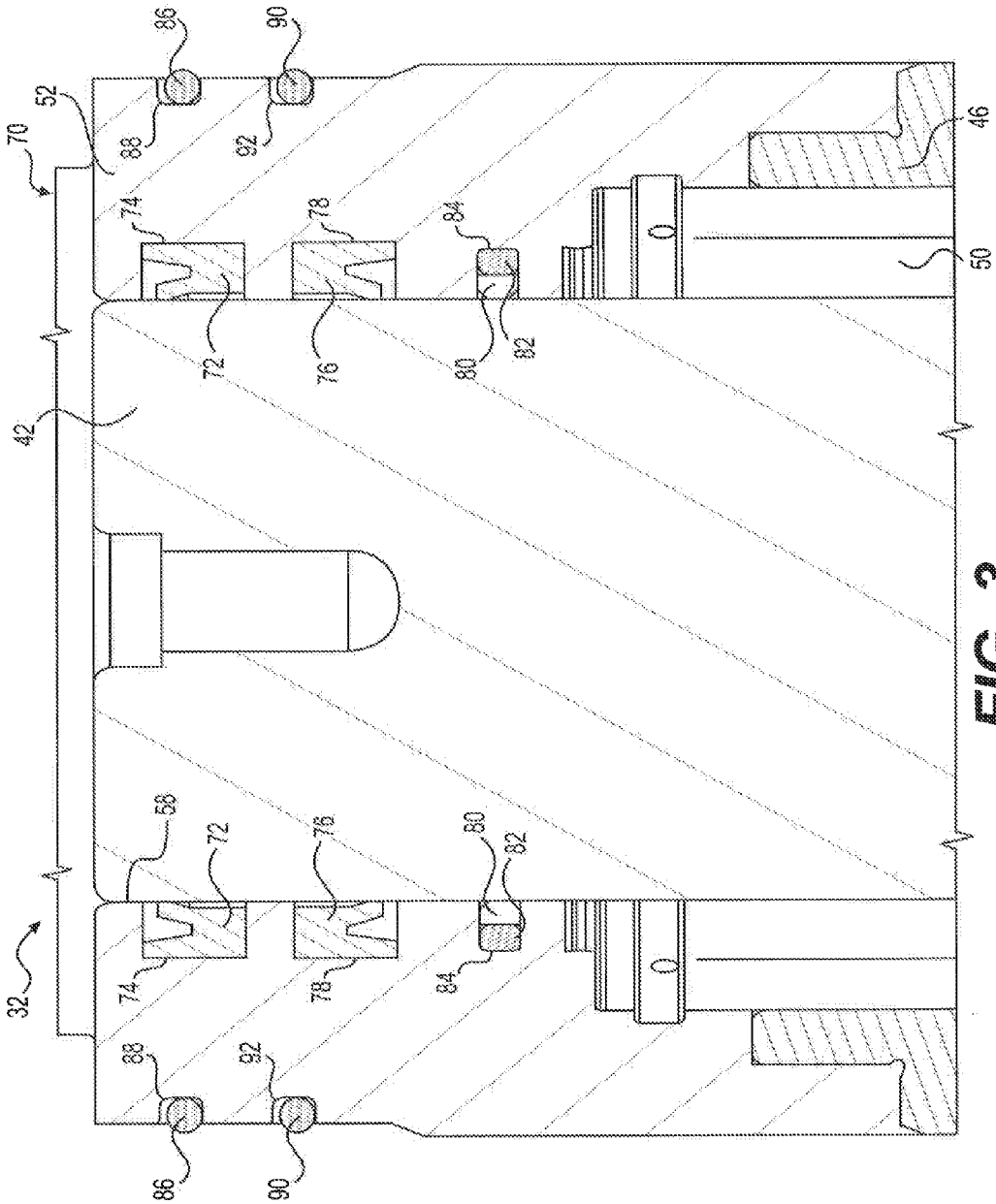


FIG. 3

HYDRAULIC HAMMER HAVING SINGLE PIECE SEAL ASSEMBLY

TECHNICAL FIELD

[0001] The present disclosure is directed to a hydraulic hammer and, more particularly, to a hydraulic hammer having a single piece seal assembly.

BACKGROUND

[0002] Hydraulic hammers can be attached to various machines such as excavators, backhoes, tool carriers, or other like machines for the purpose of milling stone, concrete, and other construction materials. The hydraulic hammer is mounted to a boom of the machine and connected to a hydraulic system. High pressure fluid in the hydraulic system is supplied to the hammer to drive a reciprocating piston in contact with a work tool, which in turn causes the work tool to reciprocate while in contact with the construction material.

[0003] The piston is usually included within an impact system that is surrounded and protected by an outer housing. The impact system also includes a valve that controls fluid to and away from the piston, and an accumulator that provides a reservoir of the fluid at the valve. One or more passages connect the valve with the accumulator. Additionally, one or more seals are installed within the impact system to help secure its components and provide sealing to and from the one or more passages.

[0004] An exemplary hydraulic hammer having seals is disclosed in U.S. Pat. No. 8,424,614 (the '614 patent) that issued to Henriksson on Apr. 23, 2013. Specifically, the '614 patent discloses a hydraulic hammer including a housing having a longitudinal bore, a cylinder sleeve supported in the bore, and a hammer piston reciprocally powered in the sleeve for delivering blows to a working implement. The hydraulic hammer also includes a seal ring disposed around a rear end of the piston sealingly guide the piston within the sleeve.

[0005] Although the hydraulic hammer of the '614 patent may be adequate for some applications, it may still be less than optimal. In particular, the seal-ring of the '614 patent must be installed correctly within the hydraulic hammer in order for the hammer to function properly. For example, if the seal-ring, is positioned and/or oriented incorrectly, leakage of fluid can occur, and thus, the hydraulic hammer will not function properly. In addition, installation of the seal-ring can require significant labor time and costs.

[0006] The disclosed hydraulic hammer is directed to overcoming one or more of the problems set forth above and/or other problems of the prior art.

SUMMARY

[0007] In one aspect, the present disclosure is directed to a seal assembly for a hydraulic hammer. The seal assembly may include a seal carrier having at least one annular recess. The seal assembly may also include at least one seal integrally molded onto surfaces of the at least one annular recess.

[0008] In another aspect, the present disclosure is directed to a seal assembly for a hydraulic hammer. The seal assembly may include a seal carrier fabricated from a non-metallic material. The seal carrier may have a first inner annular recess, and a second inner annular recess positioned gravitationally lower than the first inner annular recess. The seal assembly may also include a first unidirectional seal integrally molded onto surfaces of the first inner annular recess, and a second unidirectional seal integrally molded onto surfaces of the second inner annular recess.

[0009] In yet another aspect, the present disclosure is directed to a hydraulic hammer system. The hydraulic hammer system may include a frame, a piston, an accumulator membrane disposed external and co-axial to the piston, a sleeve disposed between the piston and the accumulator membrane, a valve located at an axial end of the accumulator membrane and inward of the sleeve, and a sleeve liner disposed between the accumulator membrane and the sleeve. The hydraulic hammer system may also include a seal assembly. The seal assembly may include a seal carrier co-axial with and located axially adjacent to the valve. The seal carrier may be fabricated from a non-metallic material and have a first inner annular recess, and a second inner annular recess positioned gravitationally lower than the first inner annular recess. The seal assembly may also include a first unidirectional seal integrally molded onto surfaces of the first inner annular recess, and a second unidirectional seal integrally molded onto surfaces of the second inner annular recess.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a pictorial illustration of an exemplary disclosed machine;

[0011] FIG. **2** is an exploded view illustration of an exemplary disclosed hydraulic hammer assembly that may be used with the machine of FIG. **1**; and

[0012] FIG. **3** is a cross-sectional view illustration of an exemplary disclosed seal assembly that may be used with the hydraulic hammer assembly of FIG. **2**.

DETAILED DESCRIPTION

[0013] FIG. **1** illustrates an exemplary disclosed machine **10** having a hammer **12**. Machine **10** may be configured to perform work associated with a particular industry such as, for example, mining or construction. Machine **10** may be a backhoe loader (shown in FIG. **1**), an excavator, a skid steer loader, or any other machine. Hammer **12** may be pivotally connected to machine **10** through a boom **14** and a stick **16**. However, it is contemplated that another linkage arrangement may alternatively be utilized, if desired.

[0014] In the disclosed embodiment, one or more hydraulic cylinders **18** may raise, lower, and/or swing boom **14** and stick **16** to correspondingly raise, lower, and/or swing hammer **12**. The hydraulic cylinders **18** may be connected to a hydraulic supply system (not shown) within machine **10**. Specifically, machine **10** may include a pump (not shown) connected to hydraulic cylinders **18** and to hammer **12** through one or more hydraulic supply lines (not shown). The hydraulic supply system may introduce pressurized fluid, for example oil, from the pump into the hydraulic cylinders **18** and hammer **12**. Operator controls for movement of hydraulic cylinders **18** and/or hammer **12** may be located within a cabin **20** of machine **10**.

[0015] As shown in FIGS. **1** and **2**, hammer **12** may include an outer shell **22** and an actuator assembly **26** located within outer shell **22**. Outer shell **22** may connect actuator assembly **26** to stick **16** and provide protection for actuator assembly **26**. A work tool **24** may be operatively connected to an end of actuator assembly **26** opposite stick **16**. It is contemplated that work tool **24** may include any known tool capable of interacting with hammer **12**. In one embodiment, work tool **24** includes a chisel bit.

[0016] As shown in FIG. **2**, actuator assembly **26** may include a subhousing **28**, a bushing **30**, and an impact system **32**. Subhousing **28** may include, among other things, a frame **34** and a head **36**. Frame **34** may be a hollow cylindrical body having one or more flanges or steps along its axial length. Head **36** may cap off one end of frame **34**. Specifically, one or more flanges on head **36** may couple with one or more flanges on frame **34** to provide a sealing engagement. One or more fastening mechanisms **38** may rigidly attach head **36** to frame **34**. In some embodiments, fastening mechanisms **38** may include, for example, screws, nuts, bolts, or any other means capable of securing the two components. Additionally, frame **34** and head **36** may each include holes to receive fastening mechanisms **38**.

[0017] Bushing **30** may be disposed within a tool end of subhousing **28** and may be configured to connect work tool **24** to impact system **32**. A pin **40** may connect bushing **30** to work tool **24**. When displaced by hammer **12**, work tool **24** may be configured to move a predetermined axial distance within bushing **30**.

[0018] Impact system **32** may be disposed within an actuator end of subhousing **28** and be configured to move work tool **24** when supplied with pressurized fluid. As shown by the dotted lines in FIG. **2**, impact system **32** may be an assembly including a piston **42**, an accumulator membrane **44**, a sleeve **46**, a sleeve liner **48**, a valve **50**, and a seal carrier **52**. One or more seals (not shown in FIG. **2**) may be integrally molded to seal carrier **52**, as will be discussed in greater detail below.

[0019] Sleeve liner **48** may be assembled within accumulator membrane **44**, sleeve **46** may be assembled within sleeve liner **48**, and piston **42** may be assembled within sleeve **46**. All of these components may be generally co-axial with each other. In addition, piston **42**, sleeve **46**, valve **50**, and seal carrier **52** may all be held together as a sub-assembly at least in part by way of slip-fit radial tolerances. For example, slip-fit radial tolerances may be formed between sleeve **46** and piston **42**, and between seal carrier **52** and piston **42**. Sleeve **46** may apply an inward radial pressure on piston **42**, and seal carrier **52** may apply an inward radial pressure on piston **42**. Such a configuration may help to hold sleeve **46**, seal carrier **52**, and piston **42** together as a sub-assembly.

[0020] Accumulator membrane **44** may form a cylindrical tube configured to hold a sufficient amount of pressurized fluid for hammer **12** to drive piston **42** through at least one stroke. Accumulator membrane **44** may be radially spaced apart from sleeve **46** when accumulator membrane **44** is in a relaxed state (i.e. not under pressure from pressurized gas). However, when accumulator membrane **44** is under pressure from the pressurized gas, no spacing may exist between accumulator membrane **44** and sleeve **46**, and fluid flow therebetween may be inhibited.

[0021] Valve **50** may be assembled over an end of piston **42** and located radially inward of both sleeve **46** and seal carrier **52**. A portion of seal carrier **52** may axially overlap with sleeve **46**. Additionally, valve **50** may be disposed axially external to accumulator membrane **44**. Valve **50** and seal carrier **52** may be located entirely within head **36**. Accumulator membrane **44**, sleeve **46**, and sleeve liner **48** may be located within frame **34**. Head **36** may be configured to close off an end of sleeve **46** when connected to frame **34**.

[0022] Piston **42** may be configured to slide within both frame **34** and head **36**. For example, piston **42** may be configured to reciprocate within frame **34** and contact an end of work tool **24**. Specifically, a compressible gas (e.g., nitrogen gas) may be disposed in a gas chamber (not shown) located within head **36** at an end of piston **42** opposite bushing **30**. Piston **42** may be slideably moveable within the gas chamber to increase and decrease the size of the gas chamber. A decrease in size of the gas chamber may increase the gas pressure within the gas chamber, thereby driving piston **42** downward to contact work tool **24**.

[0023] Piston **42** may comprise varying diameters along its length, for example one or more narrow diameter sections disposed axially between wider diameter sections. In the disclosed embodiment, piston **42** includes three narrow diameter sections **54**, **56**, **58**, separated by two wide diameter sections **60**, **62**. Narrow diameter sections **54**, **56**, **58** may cooperate with sleeve **46** to selectively open and close fluid pathways within sleeve **46**. Piston **42** may further include an impact end **64** having a smaller diameter than any of narrow diameter sections **54**, **56**, **58**. Impact end **64**, may be configured to contact work tool **24** within bushing **30**.

[0024] As shown in FIG. **3**, hydraulic hammer **12** may be equipped with a seal assembly **70** to secure piston **42**, sleeve **46**, and seal carrier **52** together as a sub-assembly and to provide sealing between those components. Seal assembly **70** may include seal carrier **52** and one or more seals integrally molded onto seal carrier **52** to simplify assembly. Each seal may be provided within one or more recesses of seal carrier **52**. For example, seal assembly **70** may include a first seal **72** molded onto surfaces of a first inner annular recess **74** of seal carrier **52**, and a second seal **76** molded onto surfaces of a second inner annular recess **78** of seal carrier **52**. In one embodiment, recess **78** may be positioned gravitationally lower than recess **74**. For the purposes of this disclosure, gravitationally lower may refer to a respective position once hammer **12** is assembled to a linkage of machine **10** and configured for use (e.g., as shown in FIG. **1**). In the disclosed embodiment, seals **72**, **76** may be permanently attached to seal carrier **52** after a manufacturing process, such that seals **72**, **76** and seal carrier **52** are integrally formed as a single piece assembly. By having a single piece assembly, time and costs associated with installation of the seals may be eliminated, thereby simplifying assembly of hammer **12**. In addition, problems associated with improper installation and incorrect alignment of the seals may also be eliminated.

[0025] In some embodiments, seals **72**, **76** may include unidirectional seals (e.g., U-cup seals) disposed between seal carrier **52** and piston **42**. For example, seal **72** may have a U-shaped portion oriented generally upwards with respect to gravity, while seal **76** may have a U-shaped portion oriented generally downwards with respect to gravity. The U-cup seals may cause less friction between piston **42** and seal carrier **52**, as opposed to, for instance, O-ring seals, and thus, less heat and wear of the seals is produced. Seals **72**, **76** may help to secure the sub-assembly, such that valve **50** moves up and down properly within impact system **32**. For example, seals **72**, **76** may be compressed to generate a radial force on seal carrier **52** and piston **42** that secures seal carrier **52** to piston **42**.

[0026] Also shown in FIG. **3**, seal assembly **70** may further include a third seal **80** and a fourth seal **82** molded onto surfaces of a third inner annular recess **84** of seal carrier **52**. In one embodiment, recess **84** may be positioned gravitationally lower than recesses **74**, **78**. In some embodiments, seal **80** may be molded onto seal **82**, and seal **82** may he molded onto the surfaces of recess **84**. Like seals **72**, **76**, seals **80**, **82** may

also help to secure the sub-assembly, such that valve **50** moves up and down properly within impact system **32**.

[0027] In some embodiments, seal carrier **52** may be fabricated from a non-metallic material (e.g., a plastic material including, for example, a high-temperature plastic). A plastic material seal carrier may be cheaper than a typical cast iron seal carrier. Also, the plastic material may have properties that are more suitable for molding seals **72**, **76**, **80**, **82** onto seal carrier **52**. Seals **72**, **76**, **82** may be fabricated from a rubber or polyurethane material, while seal **80** may be fabricated from a nylon material. During manufacture, seals **72**, **76**, **82** may be permanently molded onto seal carrier **52** using, for example, any bonding agent known in the art that is commonly used for molding plastic and rubber or polyurethane materials together. Similarly, seal **80** may be permanently molded onto seal **82** using, for example, any bonding agent known in the art that is commonly used for molding rubber or polyurethane and nylon materials together.

[0028] In some embodiments, a fifth seal **86** may be disposed in a first outer annular recess **88** of seal carrier **52**, while a sixth seal **90** may be disposed in a second outer annular recess **92** of seal carrier **52**. In the disclosed embodiment, seals **86**, **90** are not integrally molded onto seal carrier **52**. However, it is contemplated that seals **86**, **90** may be integrally molded onto seal carrier **52**, if desired. Seals **86**, **90** may be in the form of O-rings made from a rubber or polyurethane material. Like seals **72**, **76**, **80**, **82**, seals **86**, **90** may also help to secure the sub-assembly, such that valve **50** moves up and down properly within impact system **32**.

[0029] It is contemplated that, although seals **72**, **76**, **80**, **82** are described herein as being made from different materials than seal carrier **52**, the seals may alternatively be integrally fabricated from the same material as seal carrier **52**. For example, seal assembly **70** may be entirely made of a plastic material. This configuration may further simplify manufacture and assembly processes by providing a cheaper and simpler replacement part. Assembly and replacement of seal assembly **70** will be described in more detail in the section below.

INDUSTRIAL APPLICABILITY

[0030] The disclosed seal assembly may be used in any hydraulic hammer application. The disclosed seal assembly may be installed and removed from the hammer as a single piece assembly. More specifically, the seal assembly, being a single piece assembly, may not require placement of individual seals during assembly of the hammer. Instead, the seal assembly as a whole may be a drop-in replacement assembly, which can help reduce service and downtime of the machine. Assembly and replacement of seal assembly **70** during servicing of machine **10** will now be described in detail.

[0031] Assembly of seal assembly **70** onto hammer **12** may include sliding seal assembly **70** over narrow diameter section **58** and arranging it external and co-axial to piston **42**. Seals **72**, **76**, **80**, **82** may be compressed during this assembly, and thereby secure seal carrier **52** to piston **42**. Accordingly, seal assembly **70** may be held together as a single piece assembly, such that no individual seal installation is required.

[0032] Seal assembly **70** may be removed from hammer **12** as a single piece assembly to facilitate faster service and low downtime of machine **10**. For example, upon failure of any component of seal assembly **70** (e.g., seal **72**), instead of breaking down seal assembly **70** piece-by-piece until seal **72** is exposed, seal assembly **70** may be removed as a single piece assembly and replaced with another seal assembly **70**. Specifically, hammer **12** may be removed from a linkage of machine **10**, and actuator assembly **26** may be removed from outer shell **22**. Therefore, head **36**, frame **34**, and impact system **32** may be removed from outer shell **22**. Head **36** may then be removed from frame **34** to expose impact system **32**. Hammer **12** may be removed from the linkage before head **36** is removed from frame **34**. A user may remove seal assembly **70**, from frame **34**, as a single piece assembly and place a new seal assembly **70** into frame **34**. Head **36** may be reassembled with frame **34**, and then actuator assembly **26** may be re-installed into outer shell **22**. Hammer **12** may be re-assembled to the linkage of machine **10** after head **36** has been re-assembled to frame **34**.

[0033] The entire seal assembly **70** may be disposed and replaced with a new seal assembly **70**. As discussed above, seal carrier **52** may be made of a plastic material, which is cheaper than its metal substitutes, and therefore, replacement costs may be reduced. In some situations, the failed component, for example, seal **72**, may be serviced in a shop at a later time, after seal assembly **70** has been removed from frame **34** and the new seal assembly **70** placed into frame **34**. Therefore, seal **72** may be serviced at a slower pace without affecting the downtime of machine **10**.

[0034] The present disclosure may provide a hydraulic hammer having a single piece seal assembly that may be installed and removed from the hammer as one integral component. Therefore, a user may no longer be required to install individual seals onto the hammer. This may reduce cost and time to repair the hammer and may reduce downtime of the machine associated with the hammer. Additionally, problems associated with misalignment of the seals may be significantly reduced.

[0035] It will be apparent to those skilled in the art that various modifications and variations can be made to the hydraulic hammer of the present disclosure. Other embodiments of the hydraulic hammer will be apparent to those skilled in the art from consideration of the specification and practice of the method and system disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

What is claimed is:

1. A seal assembly for a hydraulic hammer, the seal assembly comprising;

a seal carrier having at least one annular recess; and

at least one seal integrally molded onto surfaces of the at least one annular recess.

2. The seal assembly of claim **1**, wherein the seal carrier is fabricated from a non-metallic material.

3. The seal assembly of claim **1**, wherein the at least one seal includes:

a first seal integrally molded onto surfaces of a first inner annular recess of the seal carrier; and

a second seal integrally molded onto surfaces of a second inner annular recess of the seal carrier, the second inner annular recess being positioned gravitationally lower than the first inner annular recess.

4. The seal assembly of claim **3**, wherein the first and second seals are fabricated from at least one of a rubber material or a polyurethane material.

5. The seal assembly of claim **3**, wherein the first and second seals are unidirectional seals.

6. The seal assembly of claim 5, wherein:
the first seal includes a U-shaped portion oriented generally upwards with respect to gravity; and
the second seal includes a U-shaped portion oriented generally downwards with respect to gravity.

7. The seal assembly of claim 3, further including:
a third seal integrally molded onto surfaces of a third inner annular recess of the seal carrier, the third inner annular recess being positioned gravitationally lower than both the first and second inner annular recesses; and
a fourth seal integrally molded onto the third seal.

8. The seal assembly of claim 7, wherein the third seal is fabricated from at least one of a rubber material or a polyurethane material, and the fourth seal is fabricated from a nylon material.

9. The seal assembly of claim 7, further including:
a fifth seal disposed within a first outer annular recess of the seal carrier; and
a sixth seal disposed within a second outer annular recess of the seal carrier, the second outer annular recess being positioned gravitationally lower than the first outer annular recess.

10. The seal assembly of claim 1, wherein the seal carrier and the at least one seal are both fabricated from the same material.

11. A seal assembly for a hydraulic hammer, the seal assembly comprising:
a seal carrier fabricated from a non-metallic material, the seal carrier having:
a first inner annular recess; and
a second inner annular recess positioned gravitationally lower than the first inner annular recess;
a first unidirectional seal integrally molded onto surfaces of the first inner annular recess; and
a second unidirectional seal integrally molded onto surfaces of the second inner annular recess.

12. The seal assembly of claim 11, wherein the first and second seals are fabricated from at least one of a rubber material or a polyurethane material.

13. The seal assembly of claim 11, wherein:
the first seal includes a U-shaped portion oriented generally upwards with respect to gravity; and
the second seal includes a U-shaped portion oriented generally downwards with respect to gravity.

14. The seal assembly of claim 11, further including:
a third seal integrally molded onto surfaces of a third inner annular recess of the seal carrier; and
a fourth seal integrally molded onto the third seal.

15. The seal assembly of claim 14, wherein the third seal is fabricated from at least one of a rubber material or a polyurethane material, and the fourth seal is fabricated from a nylon material.

16. A hydraulic hammer system, comprising:
a frame;
a piston;
an accumulator membrane disposed external and co-axial to the piston;
a sleeve disposed between the piston and the accumulator membrane;
a valve located at an axial end of the accumulator membrane and inward of the sleeve;
a sleeve liner disposed between the accumulator membrane and the sleeve; and
a seal assembly having:
a seal carrier co-axial with and located axially adjacent to the valve, the seal carrier being fabricated from a non-metallic material and having a first inner annular recess, and a second inner annular recess positioned gravitationally lower than the first inner annular recess;
a first unidirectional seal integrally molded onto surfaces of the first inner annular recess; and
a second unidirectional seal integrally molded onto surfaces of the second inner annular recess.

17. The hydraulic hammer system of claim 16, wherein the first and second seals are fabricated from at least one of a rubber material or a polyurethane material.

18. The hydraulic hammer system of claim 16, wherein:
the first seal includes a U-shaped portion oriented generally upwards with respect to gravity; and
the second seal includes a U-shaped portion oriented generally downwards with respect to gravity.

19. The hydraulic hammer system of claim 16, further including:
a third seal integrally molded onto surfaces of a third inner annular recess of the seal carrier; and
a fourth seal integrally molded onto the third seal.

20. The hydraulic hammer system of claim 19, wherein the third seal is fabricated from at least one of a rubber material or a polyurethane material, and the fourth seal is fabricated from a nylon material.

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