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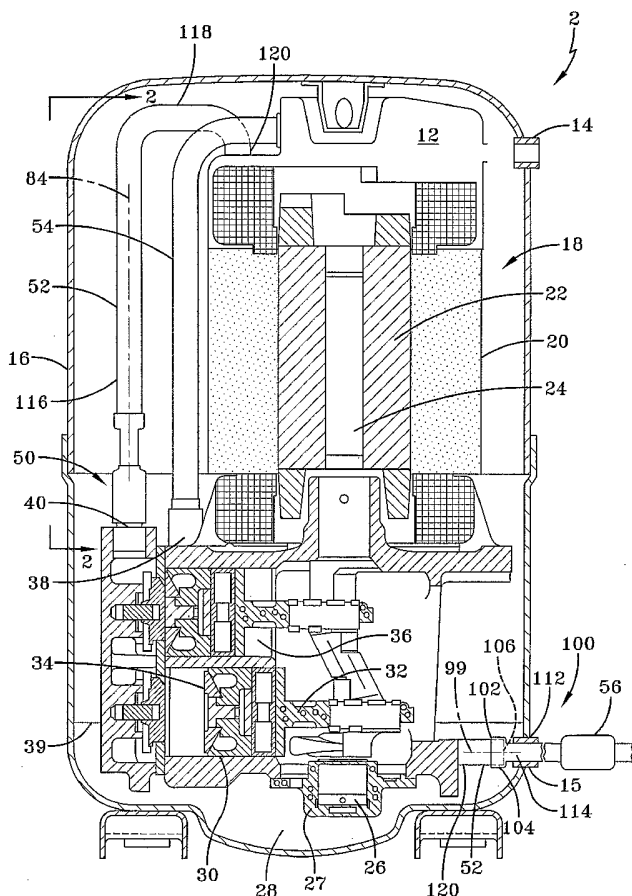
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(54) Title: DISCHARGE MUFFLER HAVING AN INTERNAL PRESSURE RELIEF VALVE



(57) Abstract: A muffler (50) for use in a refrigerant compressor (2) which includes a muffler housing (68), an intake tube at one end of the muffler housing for receiving a flow of refrigerant fluid, and an exhaust tube at another end opposed of the muffler housing (68) to exhaust the flow of refrigerant fluid. The muffler housing (68) is adapted to structurally carry a pressure relief member (60) therein. The pressure relief member (60) is in fluid communication with the intake tube. A discharge tube is connected to the exhaust tube for transporting the flow of refrigerant fluid from the exhaust tube to a compressor discharge port for discharging the refrigerant fluid from the compressor.



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DISCHARGE MUFFLER HAVING AN INTERNAL PRESSURE RELIEF VALVE

FIELD OF THE INVENTION

[0001] This Application is related to Application No. __/__, filed contemporaneously with this Application on May 19, 2003, entitled "MUFFLER SYSTEM FOR A COMPRESSOR" assigned to the assignee of the present invention and is incorporated herein by reference.

[0002] The present invention is directed to an internal muffler for use with a compressor, and more specifically to a muffler for use on the high-pressure discharge side of a compressor used in refrigeration and heating and cooling systems.

BACKGROUND OF THE INVENTION

[0003] Compressors are one of several components in cooling and heating systems. The compressor is typically used in combination with a condenser, expansion valves, an evaporator and blowers to heat or cool a space.

[0004] The compressor itself typically is a hermetically sealed device that has an intake port and a discharge port. The hermetically sealed device typically is a metallic shell that houses an electric motor and a mechanical apparatus for compressing gas. For most compressor designs, the gas cavity enclosed by the housing serves as a reservoir of low-pressure gas to be drawn into the mechanical section of the compressor. The electric motor is connected to a power source that provides line power for operation. The motor in turn drives the mechanical apparatus for compressing gas. Compressors are typically categorized by the mechanical apparatus that compresses the gas. For example, compressors using a piston device to compress the refrigerant gas are referred to as reciprocating compressors. While there are differences among the compressors as to how refrigerant gas is compressed, the basic principles of operation are common among the compressors, i.e., gas is drawn in through the gas intake during operation, the gas is compressed in the mechanical apparatus of the compressor and the highly compressed gas is discharged through an outlet port.

[0005] Various mufflers have been employed to eliminate, reduce or otherwise attenuate compressor noise. Typically, mufflers are positioned on the discharge or high pressure side of the compressor, such as at the cylinder head of a piston-driven compressor, and increase the length of flow of the gas by having it travel a tortuous path through openings of varying size or additionally define an elongate "expansion" chamber to effect sound wave stability. Placement of an expansion chamber adjacent the discharge side not only reduces operating efficiency of the compressor, but increases the overall size of the compressor. The muffler is then connected to a shockloop, also referred to as a discharge tube, that extends to a discharge port in the compressor housing that connects to a condenser that is outside the compressor housing via a conduit. Collectively, the shockloop or discharge tube is often referred as a "shockloop cane" which describes its shape. However, to regulate the discharge gas pressure level, an internal pressure relief valve (IPRV) is placed in fluid communication along the discharge path. The IPRV typically employs (within a cylindrical valve body) a spring that is maintained in a compressed condition against a plunger. The plunger overcomes the directed spring force and actuates toward an open position in the valve body of the IPRV in response to excessive discharge gas pressure levels until sufficient discharge gas is bled through the IPRV, wherein the plunger returns to its closed position within the valve body. The IPRV may be positioned downstream of the muffler, such as along the discharge tube. This is accomplished by splicing the IPRV into the discharge tube which requires the discharge tube to be severed into two separate pieces, inserting a component, such as an adapter for securing the IPRV between the severed ends of the discharge tube, then reattaching the severed ends to opposite ends of the component, which reattachment is usually accomplished by brazing. Such operations increase the number of compressor parts, the time required to assemble the compressor, and likewise, the cost to fabricate the compressor. Further, any combination of severing the discharge tube and then reattaching the severed ends of the discharge tube to opposed ends of an inserted component to achieve a contiguous discharge tube construction, especially when the method of reattachment is a heat-intensive process, will invariably impose prestresses in the discharge tube. The magnitude of these prestresses may be significantly increased if the inserted component and the discharge tube are constructed of different materials having different coefficients of expansion/contraction.

[0006] In addition to the slicing operation, the discharge tube must be subsequently manipulated to connect its ends to the respective parts inside the compressor housing.

Alignment of the ends of the discharge tube with the respective mating parts is critical to minimize the introduction of additional prestresses in the discharge tube. Typically, an end of the discharge tube is connected to the muffler via a port formed in a sidewall of the muffler housing. The muffler is typically vertically oriented within the compressor housing by threaded engagement with the cylinder head so that alignment between the muffler port and the discharge tube occurs only at a specific angular position of the muffler port about the axis of the threaded engagement. Even a slight deviation from the aligned position may introduce additional prestresses in the discharge tube possibly adversely affecting the useful life of the compressor.

[0007] What is needed is a compact, discharge-side muffler design for maintaining compressor operating efficiency while simultaneously reducing the number of compressor parts and improving the magnitude of prestresses to which the discharge tube is subjected.

SUMMARY OF THE INVENTION

[0008] The present invention relates to a discharge muffler system for use in a refrigerant compressor, including a tube inside a refrigerant compressor having a first end for receiving a flow of pressurized refrigerant fluid and a second end for exhausting the flow of pressurized refrigerant fluid. A housing surrounds the tube between the first end and the second end, the housing and the tube defining a chamber therebetween, the chamber being in fluid communication with the refrigerant fluid flowing in the tube. A pressure relief member is connected to the housing and is configured and disposed to regulate fluid pressure in the chamber. The pressure relief member regulates pressure in the chamber by actuating to an open position in response to a pressure in the chamber exceeding a predetermined pressure level to vent a portion of the refrigerant fluid in the chamber to an exterior of the housing. A unitary discharge tube receives the flow of pressurized refrigerant fluid from the second end and exhausts the flow of the pressurized refrigerant fluid from the refrigerant compressor.

[0009] The present invention also relates to a method for assembling a discharge muffler and discharge tube for use in a refrigerant compressor, the steps include: providing a discharge muffler having a muffler housing; providing an intake tube at a first end of the muffler housing for receiving a flow of refrigerant fluid, the intake tube being configured for connection with a cylinder head of a refrigerant compressor; providing an exhaust tube at a second end of the

muffler housing opposite the first end to exhaust the flow of refrigerant fluid from the discharge muffler, the exhaust tube being configured for connection with a discharge tube, and the intake tube, the exhaust tube and the connection with the cylinder head being substantially coaxial; providing a discharge tube having an intake for connection to the exhaust tube and having an exhaust for connection to a discharge port of the refrigerant compressor, the discharge tube transporting the flow of refrigerant fluid from the exhaust tube to the compressor discharge port for discharging the refrigerant fluid from the compressor; providing a driving tool for connecting the discharge muffler to the cylinder head; the driving tool having an aperture; directing the aperture of the driving tool over the exhaust tube until the driving tool and the discharge muffler are sufficiently engaged wherein the discharge muffler is actuated in response to an actuating force being applied to the driving tool; directing the intake tube of the discharge muffler in engagement with the driving tool into mutual alignment with the cylinder head; applying the actuating force to the driving tool until the discharge muffler is connected to the cylinder head; connecting the exhaust tube to the intake of the discharge tube; and connecting the exhaust of the discharge tube to the discharge port.

[0010] An advantage of the present invention is the inclusion of a compact compressor muffler for permitting reduction in the overall size of the compressor while maintaining compressor efficiency.

[0011] Another advantage of the present invention is that the muffler of the present invention is adapted to accept an IPRV therein, thereby reducing part count, labor costs and the likelihood of introducing prestresses in the discharge tube.

[0012] Another advantage of the present invention is that the assembly of the discharge tube to connect the muffler to the exhaust port in the compressor housing is greatly simplified.

[0013] Another advantage of the present invention is that the IPRV will not actuate as often within the compressor by virtue of pressure damping.

[0014] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1 is a cross-section of a refrigerant compressor that incorporates a muffler system of the present invention;

[0016] Fig. 2 is a partial elevation view of the discharge tube of the present invention taken along line II-II of Fig. 1;

[0017] Fig. 3 is a perspective view of a muffler of the present invention;

[0018] Fig. 4 is a cross-section of the muffler being joined to the discharge tube of the present invention;

[0019] Fig. 5 is a perspective view of a tool for the installing the muffler of the present invention;

[0020] Fig. 6 is an enlarged cross section of an alternate embodiment of the muffler being joined to the discharge tube of the present invention; and

[0021] Fig. 7 is an elevation view of a discharge tube of the present invention.

[0022] Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

DETAILED DESCRIPTION OF THE INVENTION

[0023] One embodiment of a compressor that incorporates the discharge muffler and discharge tube or shockloop of the present invention is depicted in Fig. 1. The compressor 2 is connected to a conventional refrigeration or heating, ventilation and air conditioning (HVAC) system (not shown), such as may be found in a refrigerator, home or automobile, having a condenser, expansion device and evaporator in fluid communication. Compressor 2 is preferably a reciprocating compressor connected to an evaporator (not shown) by a suction line that enters the suction port 14 of compressor 2. Suction port 14 is in fluid communication with suction

plenum 12. Refrigerant gas from the evaporator enters the low pressure side of compressor 2 through suction port 14 and then flows to the suction plenum 12 before being compressed.

[0024] Compressor 2 includes an electrical motor 18. A standard induction motor having a stator 20 and a rotor 22 is shown. However any other suitable type of electrical motor may be used. A shaft assembly 24 extends through rotor 22. The bottom end 26 of shaft assembly 24 opposite the motor 18 extends into a lubrication sump 28 and includes a series of apertures 27. Connected to shaft assembly 24 below the motor is at least one piston assembly 29. The compressor 2 illustrated in Fig. 1 has a cylinder head 30 having two piston assemblies 29. A connecting rod 32 is connected to the piston head 34 which moves back and forth within cylinder 36. Cylinder head 30 includes a gas inlet port 38 and a gas discharge port 40. These ports 38, 40 are associated respectively with suction valves and discharge valves assembled in a manner well known in the art. Gas inlet port 38 is connected to an intake tube 54 which is connected to the suction plenum 12 enclosed within compressor housing 16.

[0025] Upon activation of motor 18, shaft assembly 24 begins to turn or rotate. Rotation of shaft assembly 24 causes reciprocating motion of the piston assemblies. As one piston assembly moves to an intake position, i.e., as piston head 34 moves away from gas discharge port 40, a suction valve opens and refrigerant gas or vapor is introduced into an expanding cylinder 36 volume. This gas is pulled from within suction plenum 12 through intake tube 54 to gas inlet port 38 where it passes through the suction valve(s) and is introduced into cylinder 36. When a piston assembly reaches a first end (or top) of its stroke, shown by movement of piston head 34 to the right side of cylinder 36 in Fig. 1, suction valve(s) close. The piston head 34 then compresses the refrigerant gas by reducing the cylinder 36 volume. When piston assembly 29 moves to a second end (or bottom) of its stroke, shown by movement of piston head 34 to the left side of cylinder 36 in Fig. 1, discharge valve(s) are opened and the highly compressed refrigerant gas is expelled through gas discharge port 40 into a muffler 50 then through a discharge tube or shockloop 52, exiting the compressor housing 16 via an exhaust or discharge port 15. A second muffler 56 can be connected between the exhaust or discharge port 15 outlet and the condenser. This comprises one cycle of the piston assembly which is continuously repeated during operation of the compressor.

[0026] The cyclic opening and closing of the suction valve(s) along with the periodic starting and stopping of the flow of refrigerant gas generates a high level of noise over a broad frequency range. The placement of muffler 56 physically outside compressor housing 16 along the conduit connecting compressor 2 and the condenser assists in absorbing the broadband sound generated by the cyclic motion of the suction valve(s) and the cyclic surging of the gas. Further, locating muffler 56 outside compressor housing 16, not only permits a reduction in size of the compressor housing 16, but enhances the effectiveness of muffler 56 without adversely affecting the efficiency of the compressor 2. Furthermore, muffler 50 additionally regulates the cyclic gas surges by employing an IPRV 60, or any other suitable pressure relief member or valve.

[0027] Referring to Figs. 2-5, muffler 50 helps regulate cyclic gas surges by employing the IPRV 60 therein as previously discussed. Muffler 50 preferably includes a tube 62 having opposed ends 76, 78. A threaded member 64 having a lip 80 at one end is positioned over end 78 of tube 62 for threadedly engaging the cylinder head 30 to maintain tube 62 in fluid communication with gas discharge port 40. Preferably, the end 78 of tube 62 and the end of threaded member 64 opposite lip 80 are substantially coincident to ensure the parts are sufficiently engaged therebetween. Alternately, threaded portion 64 may be integrally formed with tube 62 or tube 62 may have external threads formed along its length, wherein housing opening 72 would be similarly sized with that of housing opening 70 so that the external threads of tube 62 would just slide inside the housing openings 70, 72 for ease of securing the housing openings 70, 72 of housing 68 to the tube 62. A housing 68 includes opposed openings 70, 72 which permits opening 70 of housing 68 to be positioned over end 78 of tube 62 and moved along tube 62 until opening 72 of housing 68 is in a position to sufficiently contact lip 80 when assembled. Preferably, housing 68 is coaxial with tube 62 along axis 84. Alternatively, housing 68 and threaded portion 64 may be of unitary construction. Methods of securing tube 62, housing 68 and threaded portion 64 into their respective positions can include spot welding, soldering, brazing, or by press-fit. Housing 68 is substantially cylindrical in profile and defines an annular chamber 82 between tube 62 and housing 68. Tube 62 and housing 68 are preferably maintained in fluid communication by a pair of apertures 66 formed in tube 62. However, any number of apertures 66 can be used to maintain this fluid connection.

[0028] An additional aspect of the apertures 66 is to regulate the amount of lubricant oil, also referred to as lubricant liquid, that may collect within the housing 68 of the muffler 50 during operation of the compressor. If the amount of lubricant oil 67 within the housing 68 is not regulated below a certain maximum level, the lubricant oil may adversely affect the noise attenuation capability of the muffler 50, possibly including shifting the attenuating frequency to which muffler 50 is tuned. Since the muffler is oriented substantially vertical within the compressor housing 68, the lower aperture 66 is vertically positioned along tube 62 to maintain the lubricant oil 67 at an acceptable level within the housing 68. When the level of the lubricant oil 67 in the housing 68 rises sufficiently above the lower portion of aperture 66, the lubricant oil 67 simply drains through the lower aperture 66 down tube 62, returning to the cylinder head 30.

[0029] Chamber 82 of muffler 50 displaces significantly less volume than mufflers which employ an expansion chamber. Although not necessarily drawn to scale in Fig. 4, chamber 82 displaces a comparable volume as compared to tube 62. By virtue of this lack of pronounced volumetric increase of chamber 82 that is adjacent the discharge port 40, compressor efficiency is maintained. Additionally, the small size of housing 68 permits reduction in size of the compressor housing 16.

[0030] Muffler 50 further provides for the integral mounting of IPRV 60 therein. A boss 74 preferably is formed in housing 68, which extends outwardly or inwardly from housing 68 such as by extrusion or other suitable techniques, permitting IPRV 60 to be secured therein by any usual method known in the art such as press fit, threading, adhesive or metal-joining processes involving elevated temperatures. Preferably, boss 74 extends radially outward from axis 84 which defines a side branch mounting for IPRV 60 that saves further space within the compressor housing 16. Alternately, an aperture may be formed in housing 68 without boss 74 that is sized to receive the IPRV 60. In addition to the space savings made possible by the integral muffler/IPRV construction, due to the pair of apertures 66 formed in tube 62 being in fluid communication with chamber 82 of housing 68, the pressure pulses from the discharge port 40 are dampened, thus significantly reducing the number of IPRV 60 "actuations" to resolve such over-pressure conditions. Among the over-pressure conditions causing IPRV 60 actuations are compressor start-ups and changes in compressor operating conditions. The noise generated by the IPRV 60 is generally considered undesirable.

[0031] Due to the compact construction of housing 68, for a given material thickness, housing 68 has enhanced stiffness and strength as compared to a conventional muffler having an expansion chamber. This enhanced stiffness not only helps support the IPRV 60, but also permits muffler 50 to be collectively threadedly installed onto the cylinder head 30 by a slotted driving tool 86 (see Fig. 5) having an aperture 90 of sufficient size and depth to collectively slide over tube 62 and housing 68 of muffler 50. Driving tool 86 further has at least one slot 92 formed along its peripheral edge 93 that is adapted or configured to engage the boss 74 protruding from housing 68. In other words, to utilize driving tool 86, the driving tool 86 and the muffler 50 are brought into mutual axial alignment with axis 84. Peripheral edge 93 of driving tool 86 is then directed along axis 84 in direction 97 so that peripheral edge 93 first slides over end 76 of tube 62 of muffler 50. Driving tool 86 is then continually directed incrementally in direction 97 to slide over muffler 50 until slot 92 of driving tool 86 sufficiently engages boss 74 of housing 68 of muffler 50. Once the driving tool 86 is engaged with muffler 50, end 78 of threaded portion 64 of muffler 50 is then further axially aligned along axis 84 and brought into threaded engagement with the corresponding threaded discharge aperture in the cylinder head 30. By then applying a rotational force 88 about axis 84 to driving tool 86, slot 92 imparts a rotational force along a portion of boss 74 thereby urging muffler 50 into rotational movement about axis 84 until threaded portion 64 is sufficiently threadedly engaged with the cylinder head 30. If there is sufficient clearance, IPRV 60 may be mounted in housing 68 of muffler 50 prior to installing muffler 50 in the cylinder head 30.

[0032] By directly mounting the IPRV 60 in the housing 68 of muffler 50, the compressor part count is reduced, and parts handling is reduced as to the discharge tube 52, which reduces prestresses in discharge tube 52. Alternately, if housing 68 of muffler 50 is constructed without the boss 74, such as the aperture previously discussed, and there is insufficient clearance to install the IPRV 60 prior to installing the muffler 50, the driving tool 86 could simply be modified to employ an inwardly directed member (not shown) to engage the aperture, but would otherwise operate the same as previously discussed. Additionally, by virtue of the connection of muffler 50 and discharge tube 52 being substantially coincident along axis 84, or coaxial, alignment between the muffler 50 and end 98 of the discharge tube 52 is maintained irrespective a deviation from a reference position about axis 84. In other words, unlike a side-mounted prior art muffler port for receiving the discharge tube, which only aligns with the discharge tube at a

specific rotation position or orientation about its axis of rotation, the muffler 50 and end 98 of discharge tube 52 of the present invention are always in alignment. Therefore, installation of the discharge tube is greatly eased, since the installer must only be concerned with a proper installation torque to install the muffler 50 in the cylinder head, not the possibility of applying insufficient or excessive installation torque to the muffler in an attempt to achieve the specific alignment orientation required between the muffler and the discharge tube.

[0033] One end of discharge tube 52 is connected to muffler 50. The other end of discharge tube 52 is connected to the discharge outlet 15 of compressor 2. A portion of the discharge tube 52 adjacent muffler 50 preferably has a cane or inverted "J" shape, but can have any suitable shape. Referring to Fig. 7, the discharge tube 52 is preferably of continuous, integral construction extending between the muffler and the discharge outlet 15. The shape of discharge tube 52 is primarily driven by the location and attitude of the two interface locations within the compressor housing 16 while maintaining sufficient spacing from compressor components. Thus, the path of the unitary discharge tube 52 typically follows a path adjacent the compressor housing 16, preferably including from end 98 a substantially straight portion 116 which extends into a substantially curved portion 118 and which similarly extends into a remaining portion 120 that terminates at end 106. Referring back to Figs. 1, 4 and 6, both tube 62 of muffler 50 and a portion of discharge tube 52 share a coincident axis 84. The segment or portion of discharge tube 52 that extends along axis 84 is of an extended length which more evenly distributes prestresses along the collective axial length of tube 52. Additionally, the joint formed between discharge tube 52 and tube 62 of muffler 50 is also coincident with axis 84. In one embodiment, tube 62 of muffler 50 has an enlarged diameter portion 94 that extends into a shoulder 96 formed therein that is coincident with axis 84.

[0034] To establish the joint between tube 62 of muffler 50 and discharge tube 52, an end 98 of exhaust tube 52 is directed inside the enlarged diameter portion 94 of tube 62 past end 76 to the extent required to form the joint, up to "bottoming out" at the shoulder 96. In an alternate embodiment, referring to Fig. 6, tube 62 may be configured to slide inside discharge tube 52. That is, end 76 of tube 62 is of substantially constant diameter. End 98 of discharge tube 52 has an enlarged diameter portion 108 which extends into a shoulder 110. After aligning end 98 of discharge tube 52 and end 76 of tube 62 with axis 84, end 76 of tube 62 is incrementally directed

inside enlarged diameter position 108 until "bottoming out" on shoulder 110 of discharge tube 52.

[0035] Discharge tube 52 connects in a similar way to discharge outlet 15. Discharge outlet 15 includes a fitting 100 that extends through an aperture 112 in the compressor housing 16. The fitting 100 is provided with a secure joint between itself and the compressor housing 16 that is both fluid tight and rigid, both to prevent the leakage of refrigerant through aperture 112 and avoid unnecessary flexure to the subsequent joints formed between both the fitting 100 and the discharge tube 52 inside the compressor housing 16 and between the conduit and the fitting 100 located outside the compressor housing 16. A fitting portion 114 of fitting 100 extends inside the compressor housing 16 which axially aligns along axis 99 with end 106 of tube 52. Fitting portion 114 that is inside compressor housing 16 includes an end 102 having an enlarged diameter portion 104.

[0036] To establish a joint between the discharge tube 52 and fitting portion 114, the end 106 of discharge tube 52 is directed past end 102 of fitting portion 114 along axis 99 into the enlarged diameter portion 104 until a joint is formed. The joint may be secured by soldering or other appropriate bonding method. Preferably, the joints for each end 98, 106 of discharge tube 52 is established prior to securing the joints. That is, end 98 of discharge tube 52 is directed into enlarged diameter portion 94 and end 106 of discharge tube 52 is directed into enlarged diameter portion 104 of fitting portion 114. Although the order of establishing each joint is not critical, by permitting ends 98, 106 of discharge tube 52 tube to slide along the respective mutual axes 84, 99 with respect to the respective enlarged diameter portions 94, 104 after each joint is created, at least a portion of the prestresses normally inherent with the installation of the discharge tube 52 may be avoided. In other words, by virtue of this variable, coincident insertion distance along enlarged diameter portion 94 between discharge tube 52 and tube 62 of muffler 50 and between discharge tube 52 and fitting portion 114, prestresses in the discharge tube 52 caused by non-alignment installation conditions may be further reduced, thereby improving the structural integrity of the compressor. Further, by providing a substantially straight or linear portion 116 in discharge tube 52 adjacent end 98, establishing the joint between end 98 of discharge tube 52 is made easier for the installer and may also reduce the magnitude of prestresses in the discharge tube 52 by permitting the improved distribution of forces due to the collective extended lengths

of portions 116, 118, 120. Finally, depending upon the differences between the outer diameter of discharge tube 52 along ends 98, 106, and between respective enlarged diameter portions 94, 104, an amount of lateral movement of ends 98, 106 within the respective enlarged diameter portions 94, 104 may occur which would act to further reduce prestresses in discharge tube 52.

[0037] In an alternate embodiment, end 106 of discharge tube 52 extends through aperture 112 of discharge outlet 15 a sufficient length for connection with fitting 114. Preferably, a single brazed joint placed along aperture 112 collectively provides a secure, fluid tight seal between the housing 16, the discharge tube 52 and fitting 114 while subjecting the discharge tube 52 to minimal prestresses. In this embodiment, end 98 of tube 52 is provided with an amount of both vertical and horizontal adjustment between end 98 of tube 52 and enlarged diameter portion 94 of muffler 50 as previously discussed. End 106 of discharge tube 52 must only extend through aperture 112 of housing 16 and is not otherwise constrained, instead of being constrained to extend along the axis of another component. Further, it is possible to install discharge tube 52 after all of the other compressor components have been installed in the lower half of the compressor housing. This advantageous combination of slidable connections at each end of discharge tube 52 subjects discharge tube 52 to few if any installation prestresses.

[0038] Discharge tube 52 further provides several additional benefits regarding both improved sound attenuation and reduction of liquefied refrigerant that may collect in the sump of the compressor housing 16. Referring back to Fig. 1, remaining portion 120 of discharge tube 52 extends adjacent the bottom of compressor housing 16 before exiting at discharge port 15. Preferably a segment of remaining portion 120 extends substantially coplanar with discharge port 15. Since the level of lubricant 39 at the lubrication sump 28 is preferably maintained above or at least in contact with remaining portion 120, remaining portion 120 which receives heated discharge refrigerant fluid from the cylinder head 30 is maintained in thermal communication with lubricant 39. By virtue of this thermal communication with remaining portion 120, which becomes heated during compressor operation, the temperature of the lubricant 39 is raised such that condensed refrigerant fluid mixed with the lubricant 39 is vaporized for use by the suction side of the compressor. This removal of refrigerant from the sump lubricant 39 helps prevent the introduction of liquid refrigerant into the bearings associated with the crankshaft and motor shaft, which is undesirable, thereby minimizing the possibility of premature failure of the bearings.

Additionally, since remaining portion 120 is at least partially, if not totally, submerged by lubricant 39, this maintained intimate contact with the lubricant 39 provides improved pressure pulse attenuation as compared to an identical length of remaining portion 120 that is exposed only to refrigerant vapor.

[0039] While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

CLAIMS

What is claimed is:

1. A discharge muffler system for use in a refrigerant compressor, the discharge muffler system comprising:
 - a tube having a first end for receiving a flow of pressurized refrigerant fluid and a second end opposite the first end for exhausting the flow of pressurized refrigerant fluid;
 - a housing surrounding the tube between the first end and the second end, the housing and the tube defining a chamber therebetween, the chamber being in fluid communication with the flow of pressurized refrigerant fluid;
 - a pressure relief member connected to the housing and being configured and disposed to regulate fluid pressure in the chamber;
 - wherein the pressure relief member regulates pressure in the chamber by actuating to an open position to vent a portion of the refrigerant fluid from the chamber in response to a pressure in the chamber exceeding a predetermined pressure level; and
 - a unitary discharge tube connected to the second end of the tube to receive the flow of pressurized refrigerant fluid.
2. The discharge muffler system of claim 1 wherein the tube, the housing and the chamber form an acoustic muffler.
3. The discharge muffler system of claim 1 wherein the tube comprises at least two apertures disposed within the housing between the first end of the tube and the second tube of the tube, the at least two apertures being configured to permit flow of refrigerant fluid from the tube to the chamber.
4. The discharge muffler system of claim 3 wherein the tube has a substantially vertical orientation upon installation of the tube and at least one aperture of the at least two apertures is configured and disposed to provide a maximum level of a lubricant liquid received from the first end of the tube.

5. The discharge muffler system of claim 4 wherein the maximum level of the lubricant liquid does not substantially alter an attenuation frequency of a muffler formed from the tube, the housing and the chamber.
6. The discharge muffler system of claim 1 comprising a discharge port to exhaust the flow of pressurized refrigerant fluid from the refrigerant compressor and an end of the unitary discharge tube is connected to the discharge port and a portion of the unitary discharge tube extends substantially coplanar with the discharge port.
7. The discharge muffler system of claim 1 wherein a portion of the unitary discharge tube is in thermal communication with an amount of sump lubricant in the refrigerant compressor.
8. The discharge muffler system of claim 7 wherein the thermal communication vaporizes at least a portion of refrigerant liquid in the sump lubricant.
9. The discharge muffler system of claim 1 wherein a portion of the unitary discharge tube is in physical contact with an amount of sump lubricant in the refrigerant compressor.
10. The discharge muffler system of claim 9 wherein the physical contact between the unitary discharge tube and the sump lubricant provides an amount of pressure pulse attenuation.
11. The discharge muffler system of claim 1 wherein the second end of the tube and the connection between the second end of the tube and the unitary discharge tube are substantially coaxial.
12. A method for assembling a discharge muffler system for use in a refrigerant compressor, the steps comprising:

providing a discharge muffler having a muffler housing, an intake tube at a first end of the muffler housing for receiving a flow of refrigerant fluid and an exhaust tube at a second end of the muffler housing opposite the first end to exhaust the flow of refrigerant fluid, the intake tube being configured for connection with a cylinder head of a refrigerant compressor, and the intake tube, the exhaust tube and the connection with the cylinder head being substantially coaxial;

providing a discharge tube having an intake for connection to the exhaust tube and having an exhaust for connection to a discharge port of the refrigerant compressor, the discharge tube transporting the flow of refrigerant fluid from the

exhaust tube to the discharge port for discharging the refrigerant fluid from the compressor;

providing a driving tool for connecting the discharge muffler to the cylinder head, the driving tool having an aperture;

directing the aperture of the driving tool over the exhaust tube until the driving tool and the discharge muffler are sufficiently engaged, wherein the discharge muffler is actuated in response to an actuating force being applied to the driving tool;

directing the intake tube of the discharge muffler in engagement with the driving tool into mutual alignment with the cylinder head;

applying the actuating force to the driving tool until the discharge muffler is connected to the cylinder head;

connecting the second end to the intake; and

connecting the exhaust to the discharge port.

13. The method of claim 12 wherein discharge muffler includes a pressure relief member, the muffler housing having a boss formed therein to structurally carry the pressure relief member, and the pressure relief member and the intake tube being in fluid communication; and

the step of directing the aperture of the driving tool over the exhaust tube further comprising the step of directing the aperture of the driving tool over the exhaust tube until the boss and the driving tool are sufficiently engaged.

14. A discharge muffler system for use in a refrigerant compressor, comprising:

a muffler housing;

an intake tube disposed at a first end of the muffler housing for receiving a flow of pressurized refrigerant fluid from a connection with a cylinder head of a refrigerant compressor, the intake tube and the connection with the cylinder head being substantially coaxial;

an exhaust tube disposed at a second end of the muffler housing opposite the first end of the muffler housing to exhaust the flow of pressurized refrigerant fluid, the muffler housing surrounding the intake tube and the exhaust tube between the first end and the second end to define a chamber therebetween, the chamber being in

fluid communication with the refrigerant fluid flowing in the intake tube, and the intake tube and the exhaust tube being substantially coaxial;

a pressure relief member connected to the housing and being configured and disposed to regulate fluid pressure in the chamber; and

wherein the pressure relief member regulates pressure in the chamber by actuating to an open position in response to a pressure in the chamber exceeding a predetermined pressure level to vent a portion of the refrigerant fluid in the chamber to an exterior of the housing; and

a unitary discharge tube receiving the flow of pressurized refrigerant fluid from the exhaust tube and exhausting the flow of the pressurized refrigerant fluid from the refrigerant compressor.

15. The discharge muffler system of claim 14 wherein a muffler comprising the intake tube, the exhaust tube, the muffler housing and the chamber is an acoustic muffler.
16. The discharge muffler system of claim 14 wherein the intake tube and the exhaust tube are integral and continuous, defining a combined tube.
17. The discharge muffler system of claim 16 wherein the combined tube comprises at least two apertures disposed within the housing between the first end of the combined tube and the second tube of the combined tube, the at least two apertures being configured to permit flow of refrigerant fluid from the combined tube to the chamber.

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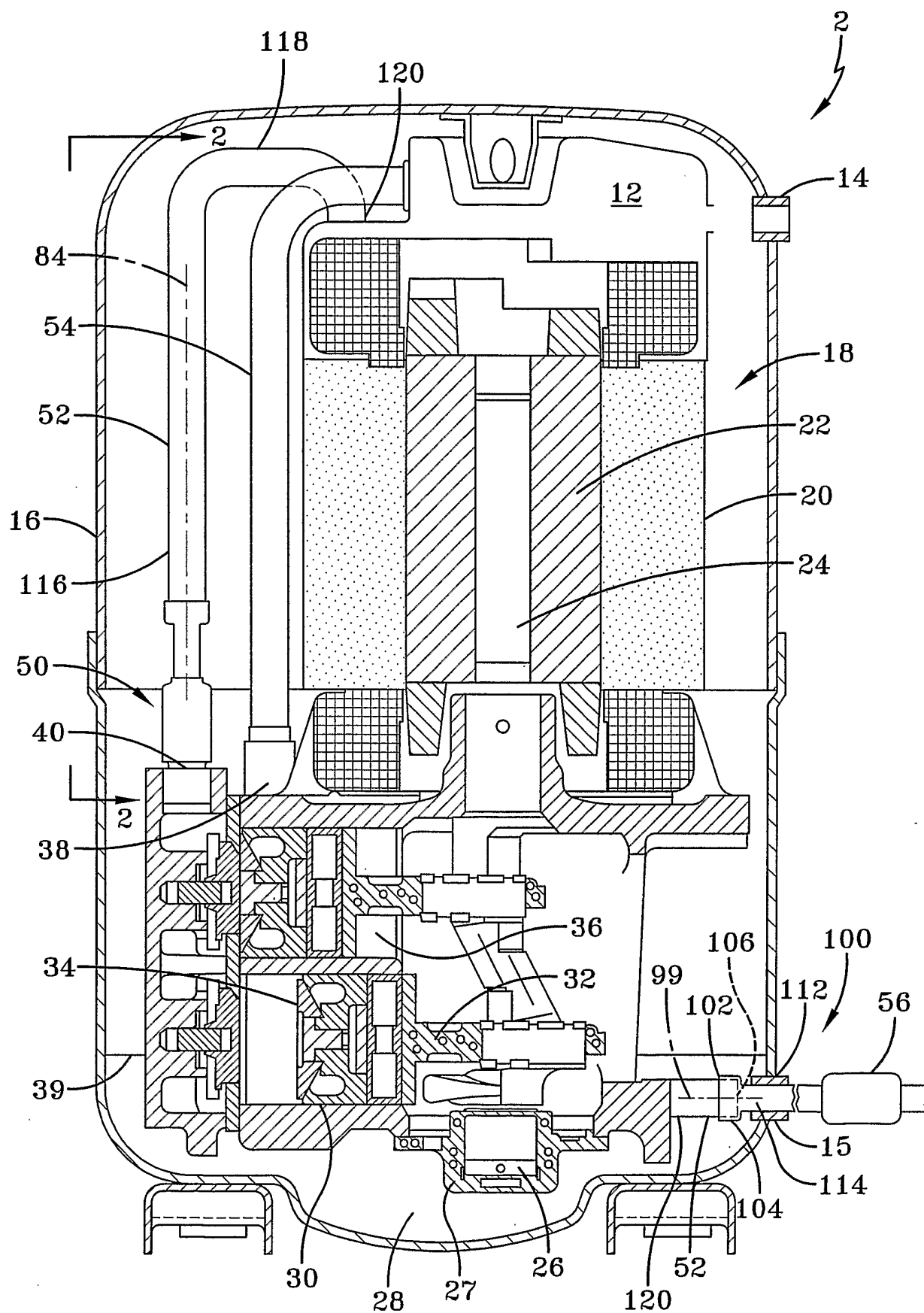


FIG-1

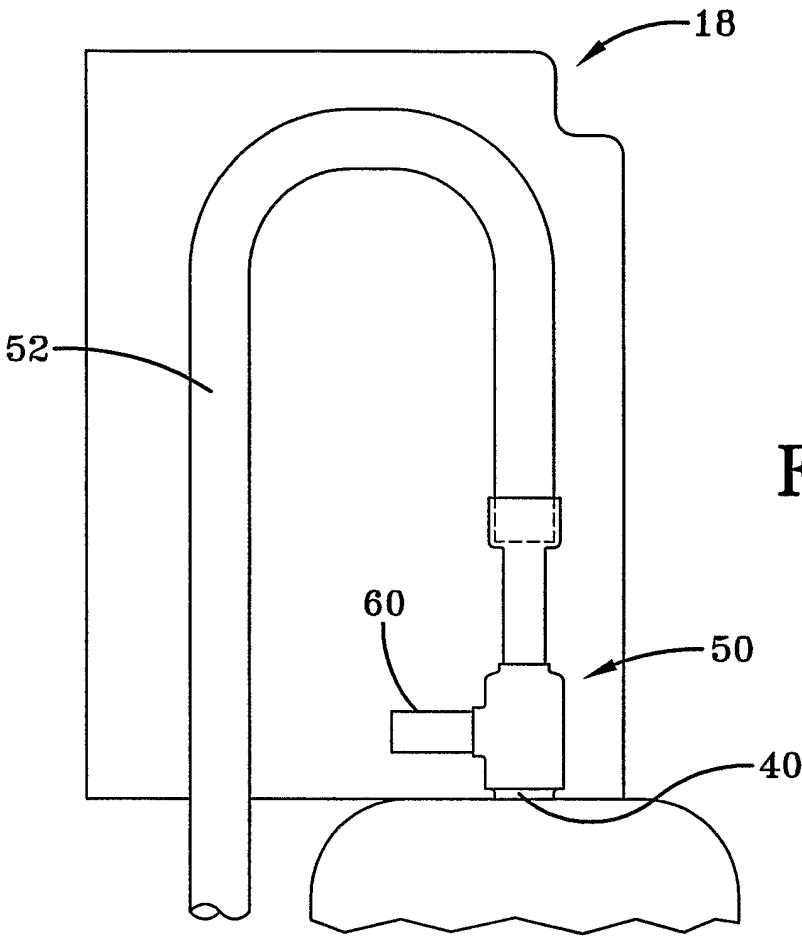


FIG-2

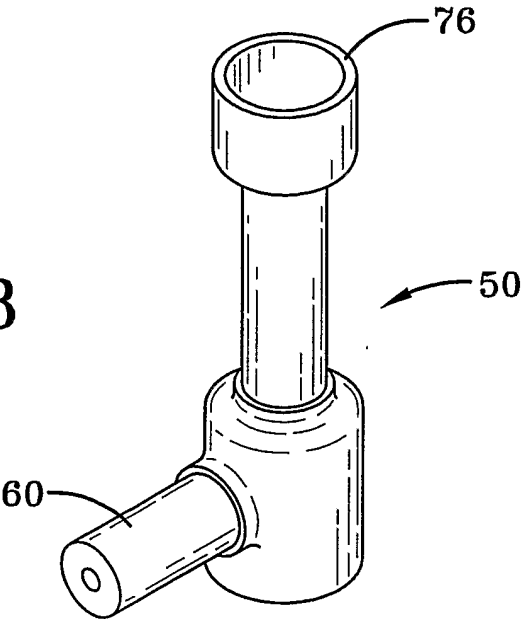


FIG-3

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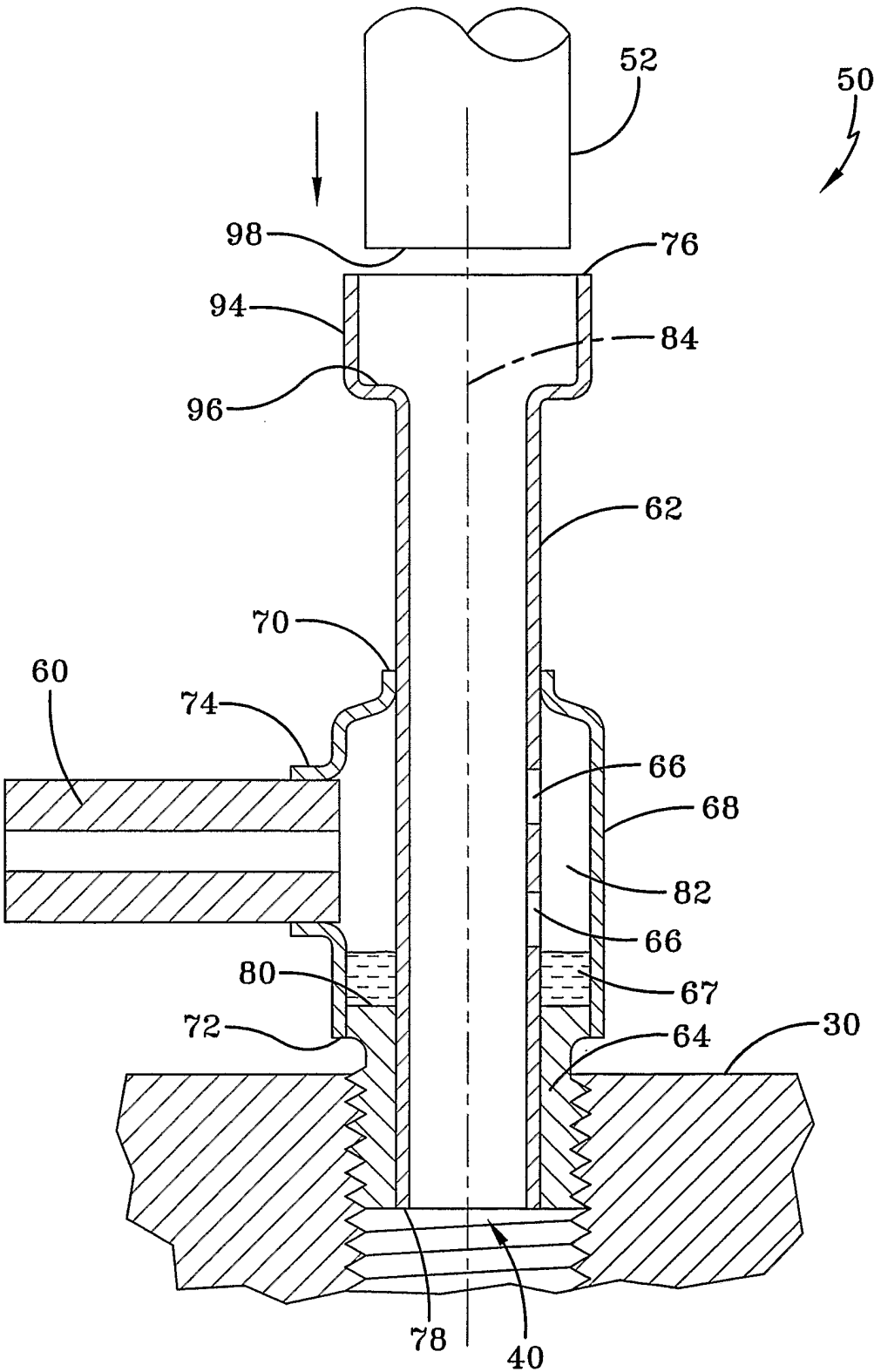


FIG-4

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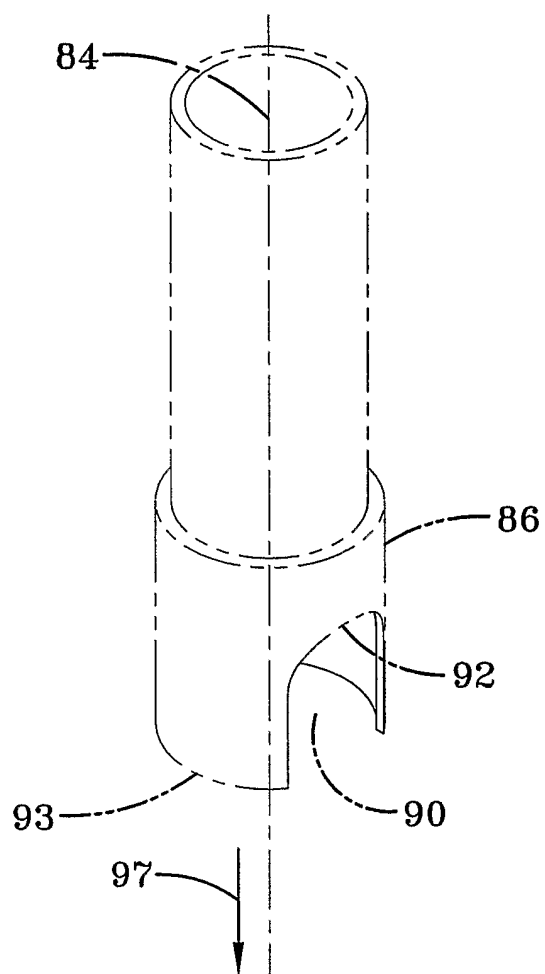
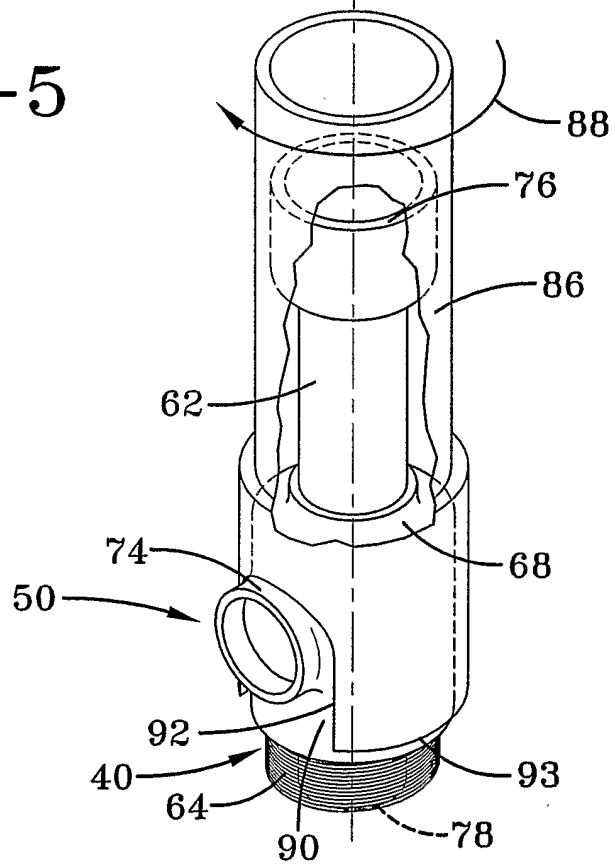


FIG-5



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FIG-6

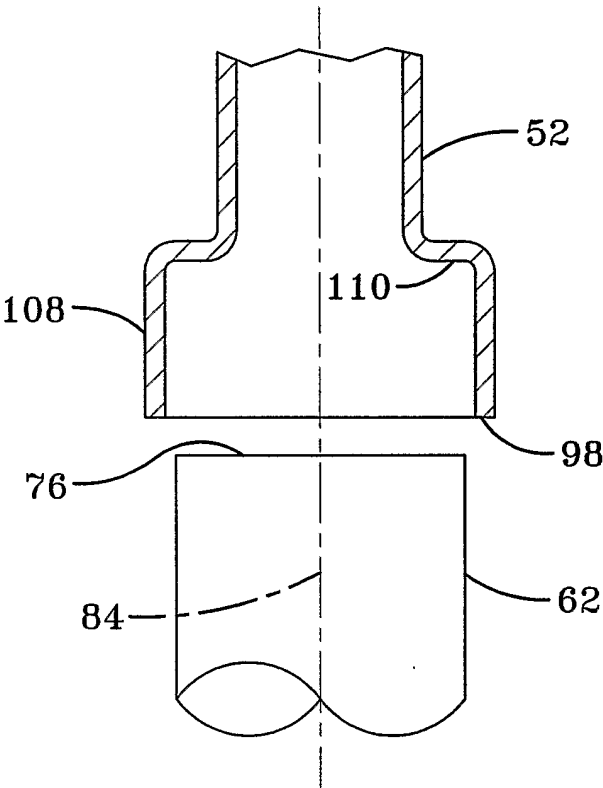


FIG-7

