REDUCING FLOW NOISE IN A REFRIGERANT EXPANSION VALVE

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ABSTRACT

A combination thermally responsive refrigerant expansion valve with integral electrically operated inlet shutoff valve having an inlet shutoff valve seat surrounded by a flow diffuser which eliminates undesirable flow noise. In the preferred embodiment the diffuser comprises a plurality of radially extending flow channels formed adjacent the inlet shutoff valve seat integrally in a one-piece valve seat member.
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BACKGROUND OF THE INVENTION

[0001] The present invention relates to refrigerant expansion valves of the type typically operated by a thermally responsive sensor such as a fluid filled capsule and which employ in combination an electrically operated shutoff valve at the inlet of the expansion valve. Valves of this type are commonly employed in motor vehicle passenger compartment air conditioning systems where high ambient thermal load gradients are encountered and rapid changes in refrigerant flow are often required to maintain passenger comfort.

[0002] Heretofore, such combination thermally operated expansion valves with an electrically operated inlet shutoff valve have experienced problems of flow noise and particularly high frequency noise characterized as “hissing” which has been found to be unacceptable from the standpoint of the vehicle occupants.

[0003] Referring to FIG. 3, a known combination thermal expansion valve and electrically operated inlet shutoff valve is indicated generally at 1 and includes a solenoid operator indicated generally at 2 attached to the valve block of a thermal expansion valve indicated generally at 3. The valve block 4 has an inlet 5 and an outlet 6 with a expansion valve member 7 therebetween which is moveable by an operating member 8. It will be understood that the operating member 8 is moved by a thermally responsible sensing unit or capsule (not shown) as is well known in the art of automotive refrigerant expansion valves.

[0004] A riser passage 9 communicates the flow from inlet 5 through a spider clip 10 and the inner periphery of a sealing washer 11 which retains a valve seat member 12 in the block. Valve seat member 12 defines an inlet valve seat 13 against which is moved a shutoff valve member 14, which in turn is moved by an armature 15 forming part of the solenoid operator 2 which includes a solenoid coil 16 surrounding the armature 15. A pilot passage 18 is formed in the shutoff valve member 18 with a pilot valve member 19 seated on the upper end thereof. The prior art valve assembly shown in FIG. 3 has been found to exhibit a prohibitive amount of flow noise which is generated in the region of the spider clip 10 and washer 11 which are registered against the shoulder formed in the armature guide 17.

[0005] Accordingly, it has been desired to find a way or means of providing a refrigerant expansion valve operated by a thermally responsive member in combination with an electrically operated inlet shutoff valve which is relatively low in manufacturing cost, easy to assemble and reduces undesirable flow noise and particularly hissing. It has further been desired to provide such a combination valve which has reduced flow noise and which is sufficiently low in manufacturing cost to be suitable for high volume mass production of motor vehicle air conditioning systems.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention provides a combination refrigerant expansion valve, of the type intended to be operated by a thermally responsive unit, in combination with an electrically operated inlet shutoff valve. The valve assembly of the present invention employs an expansion valve member operating against a valve seat in a valve block; and, the valve member is retained on the valve seat and moved with respect to the valve seat by an operating rod or member of the type intended to be connected to a thermally responsive sensing capsule.

[0007] A shutoff valve seat member is received over the retainer for the expansion valve; and, a shutoff valve member is disposed thereagainst and moved with respect to the shutoff valve seat by the armature of a solenoid attached to the valve body. The shutoff valve seat has a diffuser disposed adjacent and surrounding its valve seat, which serves to direct the flow to the valve seat and reduce flow noise. In the preferred embodiment, the diffuser comprises a plurality of radially outwardly extending flow channels which direct the flow from a riser passage in the valve block communicating with the valve inlet. In the presently preferred practice the valve seat member and diffuser channels are formed integrally in a one piece, preferably cup-shaped member.

[0008] The present invention thus provides a unique and novel construction for an electrically operated inlet shutoff valve in combination with a thermal expansion valve and which is relatively low in manufacturing costs, easy to assemble and eliminates undesirable flow noise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a cross-section of the combination valve assembly of the present invention showing the expansion valve and solenoid operated inlet shutoff valve;

[0010] FIG. 2 is an enlarged perspective view of the inlet shutoff valve seat of the embodiment of FIG. 1; and,

[0011] FIG. 3 is a view similar to FIG. 1 of a prior art valve assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Referring to FIG. 1, the combination valve assembly of the present invention is indicated generally at 20 and includes an electrically energizable solenoid operator indicated generally at 22 attached to an expansion valve indicated generally at 24. The valve 24 has a valve block 26 with a high pressure inlet passage 28 formed therein which communicates with a riser passage 30. The valve block 26 has a moveable expansion valve member 32 disposed therein against a valve seat 34; and, the block has an outlet 36 which communicates with the valve seat via a passage 38.

[0013] The expansion valve member 32 is moved by an operating member or rod 40 which is intended for connection to a thermally responsive sensor (not shown) such as a fluid filled temperature sensing capsule well known in the art.

[0014] The expansion valve member 32, preferably in the form of a spherical member, is biased to the closed position against seat 34 by a cap 42 which is contacted by the lower end of a spring 44 which has its upper end registered against the end of a counterbore formed in an annular retainer 46 which threadedly engages the block as denoted by reference numeral 48. Retainer 46 is rotatable in the threads 48 for adjusting the preload of spring 44 on the expansion valve member 32. The member 46 has a central passage therethrough denoted by reference numeral 50 which communicates with the expansion valve seat 34.

[0015] An inlet shutoff valve seat member 52 having a generally cup-shaped configuration is received over the spring retainer 46 and sealed thereover by a seal ring 50. Shutoff valve seat member 52 has a passage 56 formed in the
upper end thereof which communicates with an inlet shutoff valve seat 58 formed on the upper end of member 52 and which is contacted by the lower end of a shutoff valve member 60.

[0016] Valve member 60 is slidably received in a bore 62 formed in the lower end of an armature 64 which is slidably retained in a tubular armature guide member 66 which has an enlarged diameter portion 68 which opens in a radially outwardly extending annular flange 70. The armature guide member flange 70 is retained in the valve block 26 by a collar 72 threaded in the valve block and bearing against the flange 70.

[0017] The interior of the enlarged portion 68 of the armature guide 66 forms an annular chamber 71 about member 52, which chamber 71 is in open communication with riser passage 54. In the presently preferred practice, the shutoff valve member 60 has a pilot passage 74 provided therein through which has a pilot valve member 76 seated thereon and biased downwardly against the upper end of the pilot passage 74 by a spring 78 which has its upper end registered against a pole piece 80 secured to the upper end of the armature guide in a fluid type arrangement as, for example, by weldment or interference fit.

[0018] Armature 64 forms a working air gap 82 at its upper end with the lower surface of the pole piece 80. A coil bobbin 84 with a coil 86 wound thereon is received over the armature guide and retained thereon by a cap 88 secured by a clip 90 pressed over the pole piece 80. A cylindrical casing 92 is received over the coil for completing a flux loop thereabout. An annular inner flux collector member 94 is provided over the armature guide within the bobbin at the lower end thereof in the presently preferred construction.

[0019] Upon energization, the coil 86 causes the armature to move upwardly closing air gap 82 and lifting the pilot valve member 76 causing flow from above the main valve member to exit through the pilot passage 74 thereby reducing the pressure on the upper end of the armature whereupon pressure forces acting on the lower end of the armature aid in lifting the shutoff valve member 60 from valve seat 58. Upon lifting of the shutoff valve member 60 from valve seat 58, fluid flows through riser passage 30 and around the valve seat member 52 over valve seat 58 and through passage 56 through passage 50 in retainer 46 to the expansion valve 32.

[0020] Referring to FIG. 2, the shutoff valve seat member 52 is shown with a diffuser indicated generally at 96 which includes a plurality of radially extending channels 98, 100, 102, 104 formed in the upper end of member 52 and feeding to the inlet side of the valve seat surface 58. Thus, the channels 98, 100, 102, 104 diffuse the flow and tend to reduce turbulence and serve to eliminate undesirable flow noise. Although the diffuser 96 is shown in the form of radial channels or grooves formed in the upper end of the member 52 in a unitary one-piece arrangement, it will be understood that the diffuser may be configured otherwise where, for example, channels 96-102 may be formed as bores and may alternatively be formed in a separate member from member 52.

[0021] The present invention thus provides a unique and novel combination of a thermal expansion valve and electrically operated inlet shutoff valve having a diffuser on the inlet side of the shutoff valve seat to reduce flow noise.

[0022] Although the invention has hereinabove been described with respect to the illustrated embodiments, it will be understood that the invention is capable of modification and variation and is limited only by the following claims.

1. A thermally responsive expansion valve assembly having an electrically operated shutoff valve in the inlet thereof comprising:
   (a) a valve body having an inlet and outlet and an expansion valve member moveable by an operating member adapted for connection to a thermally responsive element for controlling flow between the inlet and outlet;
   (b) a shutoff valve member disposed between the main valve member and the inlet;
   (c) a valve seat member disposed adjacent said shutoff valve member, said valve seat member having an annular seating surface and a diffuser disposed between said inlet and said annular seating surface; and,
   (d) a solenoid operator attached to said body and having an armature operably connected for effecting movement of said shutoff valve member upon energization of the solenoid.

2. The valve assembly defined in claim 1, wherein said diffuser includes plurality of radially extending passages surrounding said annular seating surface.

3. The valve assembly defined in claim 1, further comprising a pilot valve member operable, upon energization of the solenoid, for opening a pilot passage through said shutoff valve member.

4. The valve assembly defined in claim 1, wherein said annular seating surface and said diffuser are formed integrally in a one piece member.

5. The valve assembly defined in claim 1, wherein said valve seat member has an inverted cup-shaped configuration and said diffuser comprises a plurality of radially extending channels formed on the closed end thereof surrounding said annular seating surface.

6. A method of making a thermally responsive expansion valve assembly having an electrically operated shutoff valve in the inlet thereof comprising:
   (a) disposing an expansion valve member moveable in a valve body and disposing an operating member from a thermally responsive unit in contact with the expansion valve member, and forming an inlet and outlet in the body communicating with the expansion valve member;
   (b) disposing a shutoff valve member and an annular valve seat between the expansion valve member and the inlet;
   (c) disposing a diffuser adjacent said annular valve seat on the upstream side thereof; and,
   (d) disposing a solenoid operator on said valve body and energizing the solenoid and moving the shutoff valve member with the solenoid armature.

7. The method defined in claim 6, wherein the step of disposing a diffuser includes forming a plurality of radially extending passages surrounding said annular valve seat.

8. The method defined in claim 6, wherein the step of disposing an inlet valve member includes forming said pilot passage in the inlet valve member and disposing a pilot valve therewith.

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