A refrigerant system (20) is provided with an enlarged chamber (32) that provides the functions of both an oil separator and a muffler. The chamber includes an oil return line (34) that returns separated oil back to a compressor. The chamber further includes at least one sound-deadening feature such that the chamber will also deaden the sound caused by the compressed refrigerant as it moves downstream from the compressor towards the condenser. In one embodiment, the sound-deadening feature is a torturous path (40) for the compressor discharge flow. In another embodiment, the sound-deadening feature is a sound-deadening material (52) formed within the chamber. Additional oil separation features may include an oil retention mesh (36) or a cyclone structure (102).
COMBINED MUFFLER AND OIL SEPARATOR FOR REFRIGERANT SYSTEM

BACKGROUND OF THE INVENTION

[0001] This application relates to single component mounted downstream of a compressor in a system utilizing compressed vapor, and in a heating, ventilation, air conditioning or refrigeration (HVAC&R) system in particular, wherein the single component provides the function of both an oil separator and a muffler.

[0002] Refrigerant systems are utilized in many applications to condition an environment. In particular, air conditioners and heat pumps are employed to cool and/or heat air entering the environment. The cooling or heating load of the environment may vary with ambient conditions, occupancy level, other changes in sensible and latent load demands, and as the temperature and/or humidity set points are adjusted by an occupant of the environment.

[0003] In the prior art, it is known to position a muffler downstream of the compressor. The muffler operates to reduce the discharge pulsations, refrigerant flow velocity and consequently radiated noise from the compressed refrigerant moving downstream of the compressor. Various muffler structures are known, but in general a muffler has an enlarged cavity with a flow cross-sectional area greater than the discharge line leading into the muffler. The movement of the compressed refrigerant into the larger cross-sectional area, combined with various muffling features, reduces the radiated noise. Examples of the muffling features would include sound-deadening coatings within the muffler chamber, baffles of various shapes, etc.

[0004] It is also known to position an oil separator downstream of the compressor. The compressed refrigerant leaving the compressor discharge port may often carry excessive amount of oil out of a compressor housing. It is undesirable to have excessive amount of oil leaving the compressor, since it may eventually lead to permanent compressor damage (due to oil pumpout conditions) as well as may cause detrimental heat transfer effects (due to presence of oil in the heat exchangers). Thus, oil separators have been positioned downstream of the compressors. The oil separators have typically included an enlarged chamber and may include additional structure for removing oil from the refrigerant. As an example, an oil retention mesh or a cyclone structure causing centrifugal motion of the oil-refrigerant flow may be placed within the chamber. As the refrigerant moves through the mesh, the oil is removed from the refrigerant. Also, centrifugal forces act differently on substances having distinct densities, and on vapor refrigerant and liquid oil in particular, separating them from each other. An oil return line returns separated oil back to the compressor.

[0005] To date, the functions of the muffler and the oil separator have not been combined within an HVAC&R system.

SUMMARY OF THE INVENTION

[0006] In a disclosed embodiment of this invention, an enlarged chamber is positioned downstream of a compressor discharge line. This enlarged chamber has an oil return line for returning separated oil back to the compressor. In addition, this enlarged chamber has at least one sound-muffling feature. Thus, the present invention provides a single enlarged chamber to perform the functions of both an oil separator and a muffler that have been provided in the prior art by separate chambers.

[0007] In disclosed embodiments, a mesh, which may be a wire mesh, perforated plate or any other compatible porous material, extends across the enlarged chamber to assist in oil separation. In another embodiment, a cyclone structure causing swirling motion may be placed within the chamber to help in separating oil by centrifugal forces. Further, the sound-deadening feature may be represented by the baffles in one embodiment, perforated structure in another embodiment or a sound-deadening material in still another embodiment.

[0008] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1A is a schematic view of a refrigerant system incorporating the present invention.

[0010] FIG. 1B is another embodiment.

[0011] FIG. 2 shows a combined oil separator and muffler structure.

[0012] FIG. 3 shows another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] A refrigerant system 20 is illustrated in FIG. 1 having a compressor 22 compressing a refrigerant and delivering it downstream to a condenser 24. An expansion device 26 is positioned downstream of the condenser 24, and an evaporator 28 is positioned downstream of the expansion device 26. Refrigerant flows from the compressor through the condenser 24, the expansion device 26, the evaporator 28, and back to the compressor 22. It should be understood that this is a very simplified schematic view of a refrigerant system, and many other components and features may be incorporated into the circuitry.

[0014] A discharge line 30 accepts compressed refrigerant downstream from the compressor 22 and directs it towards the condenser 24. A combined oil separator and muffler 32 is positioned downstream of the compressor 22, on the line 30, and upstream of the condenser 24. As shown, separated oil 38 is returned through an oil return line 34 to the compressor 22. To facilitate the separation of the oil from the compressed refrigerant, a material such as a wire mesh, a perforated plate or an insert made from any other compatible porous material 36 may be positioned within the chamber 32. The sound-deadening feature is normally provided by selecting the size of the muffler to be large enough to provide the desired sound and pulsation attenuation. Further, baffles 40 may be additionally placed within this volume to beneficially change the acoustic characteristics of the muffler for enhancing the attenuation of discharge pressure pulsations as well assisting in oil separation. FIG. 1B shows another alternative 200 that may have a sound-deadening feature, where the muffler is comprised of at least two separate volumes V with a connecting passage or tube T placed between the two volumes. Thus, this embodiment shows a single combined chamber 32, which provides the function of oil separation and sound deadening.

[0015] FIG. 2 shows another embodiment 50, wherein the chamber 50 includes a sound-deadening material 52 on its inner surfaces. The oil-refrigerant mixture enters the chamber
50 through an inlet line 70 and separated oil 38 is returned through an oil return line 34 while vapor refrigerant leaves through an outlet line 42 towards the condenser. The sound-deadening material may include (but not limited to) insulation material or perforated structure that are generally known in the art.

[0016] FIG. 3 shows another embodiment 100 that includes cyclone structure 102 causing the swirling motion of the oil-refrigerant mixture and separating oil and vapor refrigerant by the action of centrifugal forces. As further shown in FIG. 3, a sound-deadening feature is used in combination with the cyclone separator. Any known sound-deadening feature may be used. The cyclone 102 is shown schematically. As known, as the refrigerant passes through the cyclone, the heavier oil would tend to be separated by being thrown radially further away from the centerline due to centrifugal force. That oil then falls into the oil sump 38. The cyclone separator itself is as known, and thus it is disclosed and illustrated somewhat schematically. In all other aspects, this embodiment could be similar to embodiments shown in FIGS. 1 and 2.

[0017] The present invention thus provides a single combined chamber that required two distinct components in the prior art. While two muffling features are disclosed, many others can be used with the basic technology of this invention.

[0018] Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

1-18. (canceled)

19. A refrigerant system comprising:
a compressor for compressing a refrigerant and delivering a compressed refrigerant into a discharge line;
a condenser downstream of said compressor, an expansion device downstream of said condenser, and an evaporator downstream of said expansion device, with refrigerant passing from said compressor to said condenser, to said expansion device, to said evaporator, and then returning to said compressor;
a combined oil separator and muffler positioned downstream of said compressor and upstream of said condenser, and receiving a flow of refrigerant from said discharge line, said combined oil separator and muffler comprising an enlarged chamber, and an oil return line for returning separated oil back to said compressor, and said enlarged chamber further being provided with at least one sound-deadening feature; and
said at least one sound-deadening feature includes baffles forming a tortuous path for the flow of refrigerant, said baffles also providing an oil separation function.

20. The refrigerant system as set forth in claim 19, wherein said tortuous path includes said flow of refrigerant serially encountering smaller cross-sectional areas and then enlarged cross-sectional areas such that sound is deadened.

21. The refrigerant system as set forth in claim 19, wherein said at least one sound-deadening feature includes a sound-deadening material formed on inner surfaces of said inner chamber.

22. The refrigerant system as set forth in claim 19, wherein said chamber includes an oil separating structure.

23. The refrigerant system as set forth in claim 22, wherein said oil separating structure includes at least one of the following elements selected from the list of being a mesh structure, a perforated plate structure, a porous material structure, a centrifugal cyclone structure, a baffle plate structure or a combination thereof extending across said chamber to remove oil from the compressed refrigerant.

24. The refrigerant system as set forth in claim 23, wherein said oil separating structure is a wire mesh.

25. The refrigerant system as set forth in claim 24, wherein said oil separating structure is a cyclone separator.

26. The refrigerant system as set forth in claim 19, wherein said oil return line leaves said combined oil separator and muffler at a vertically lower location, and the flow of refrigerant leaves said combined oil separator and muffler at a vertically upper location spaced vertically upwardly from said vertically lower location.

27. A combined oil separator and muffler for use in a position downstream of a compressor,
said combined oil separator and muffler including a body for receiving a flow of gas from a discharge line of the compressor, said body comprising an enlarged chamber and an oil return line for returning separated oil back to the compressor;
said enlarged chamber further being provided with at least one sound-deadening feature; and
said at least one sound-deadening feature includes baffles forming a tortuous path for the flow of refrigerant, said baffles also providing an oil separation function.

28. The combined oil separator and muffler as set forth in claim 27, wherein said tortuous path includes said flow of refrigerant serially encountering smaller cross-sectional areas and then enlarged cross-sectional areas such that sound is deadened.

29. The combined oil separator and muffler as set forth in claim 27, wherein said at least one sound-deadening feature includes a sound-deadening material formed on inner surfaces of said inner chamber.

30. The combined oil separator and muffler as set forth in claim 27, wherein said chamber includes an oil separating structure.

31. The combined oil separator and muffler as set forth in claim 30, wherein said oil separating structure includes at least one of the following elements selected from the list of being a mesh structure, a perforated plate structure, a porous material structure, a centrifugal cyclone structure, a baffle plate structure or a combination thereof extending across said chamber to remove oil from the compressed refrigerant.

32. The combined oil separator and muffler as set forth in claim 31, wherein said oil separating structure is a wire mesh.

33. The combined oil separator and muffler as set forth in claim 31, wherein said oil separating structure is a cyclone separator.

34. The combined oil separator and muffler as set forth in claim 27, wherein said oil return line leaves said combined oil separator and muffler at a vertically lower location, and the flow of refrigerant leaves said combined oil separator and muffler at a vertically upper location spaced vertically upwardly from said vertically lower location.