Oct. 18, 1938. C. H. STEENSTRUP 2,133,875

REFRIGERATING MACHINE

Filed Feb. 17, 1937

Fig. 1.

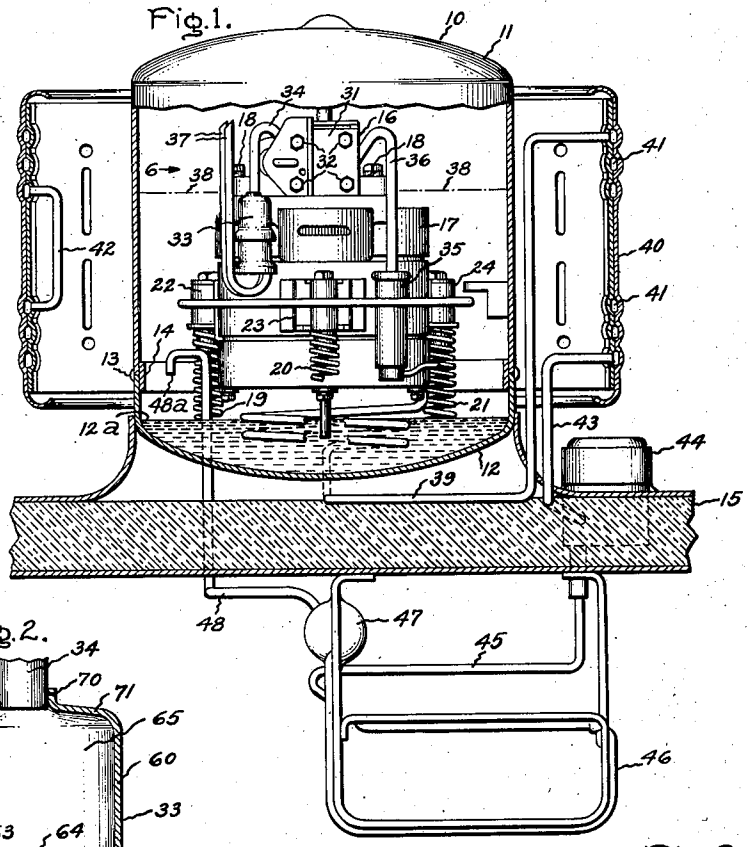


Fig. 2.

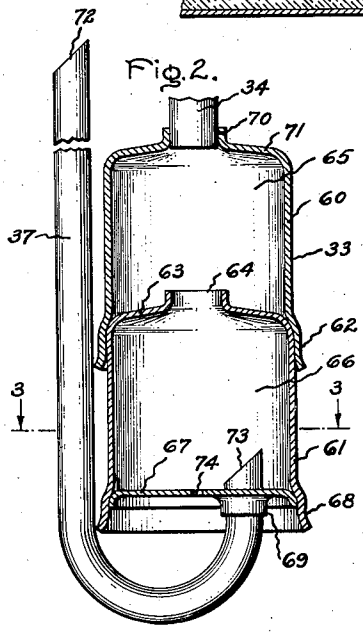


Fig. 3.

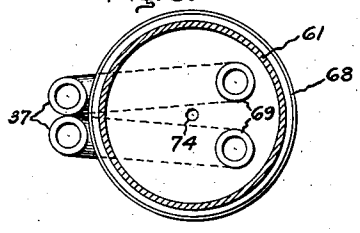


Fig. 4.

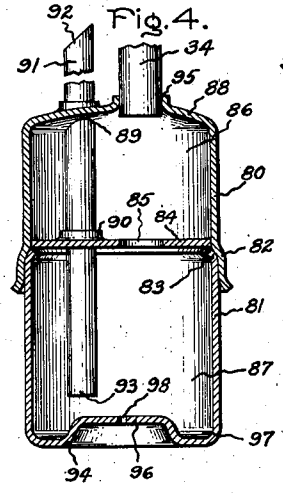


Fig. 6.

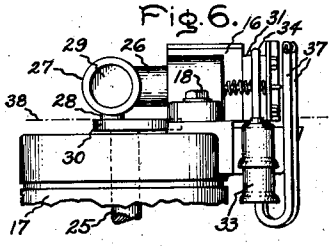
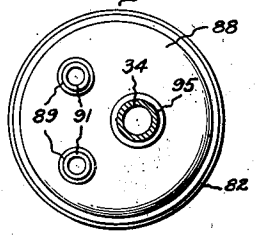


Fig. 5.



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Patented Oct. 18, 1938

2,133,875

UNITED STATES PATENT OFFICE

2,133,875

REFRIGERATING MACHINE

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Application February 17, 1937, Serial No. 126,206

5 Claims. (Cl. 230—232)

My invention relates to compression type refrigerating machines, and more particularly to an improved construction and arrangement of an intake muffler therefor.

Compression type refrigerating machines are frequently provided with a compressor and a driving motor enclosed in a casing which is preferably hermetically sealed, thus obviating the necessity of using connections with packing glands or the like between the motor and compressor, and minimizing leakage of refrigerant from the machine, as any gaseous refrigerant which escapes from the compressor is confined in the enclosing casing. It is desirable that the enclosing casing be provided with a lubricant reservoir for containing a body of lubricant which is recirculated to the bearings and moving parts of the motor and compressor during operation of the machine without the necessity of variation and replenishment, thus simplifying the maintenance of the machine. In order to minimize the transmission of operating noises of the compressor through the enclosing casing to a refrigerator cabinet it is desirable that an intake muffler be associated with the intake port of the compressor.

During the operation of a refrigerating machine of this type it is very important that no appreciable quantity of the body of lubricant contained in the lubricant reservoir formed in the enclosing casing be drawn into the cylinder of the compressor through the intake muffler, as the presence of lubricant in the compressor cylinder would give rise to excessive pressures in the cylinder resulting in damage to the valves of the compressor, lubricant being a non-compressible fluid. In actual practice, it is difficult to prevent lubricant from being drawn into the cylinder of the compressor as the body of lubricant contained in the lubricant reservoir formed in the enclosing casing often becomes frothy and rises considerably above its normal operating level in the enclosing casing into the intake zone of the intake muffler. Furthermore, during the assembly and shipment of such a refrigerating machine the enclosing casing often becomes tilted from its normally upright position allowing a portion of the body of lubricant contained in the lubricant reservoir to spill into the intake muffler, from which it is drawn into the cylinder of the compressor when the machine is started.

It is an object of my invention to provide an improved arrangement of the intake muffler in an enclosed compression type refrigerating machine in order to prevent frothy lubricant from gaining entrance into the intake muffler and the cylinder of the compressor.

Another object of my invention is to provide an improved intake muffler construction for compression type refrigerating machines which embodies an arrangement providing for the escape from the intake muffler of any lubricant accumulated therein.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing, in which Fig. 1 is a side elevation, partly in section, of a refrigerating machine embodying my invention; Fig. 2 is a vertical sectional view of the intake muffler shown in Fig. 1; Fig. 3 is a sectional view of the intake muffler along the line 3—3 of Fig. 2; Fig. 4 is a vertical sectional view of a modified form of the intake muffler shown in Fig. 2; Fig. 5 is a plan view of the intake muffler shown in Fig. 4; and Fig. 6 is a fragmentary side elevational view taken in the direction of the arrow 6 in Fig. 1 of the refrigerating machine.

Referring to the drawing, in Fig. 1 I have shown a refrigerating machine of the household type provided with a hermetically sealed casing 10 made of an upper casing section 11 and a lower casing section 12, the adjacent edges of these casing sections being welded together at 13 over a reinforcing ring 14. The casing sections 11 and 12 are preferably made of steel and are mounted on a removable cabinet top 15. A refrigerant compressor 16 and an electric driving motor 17 therefor are enclosed within the hermetically sealed casing 10. The compressor 16 is secured to the top of the driving motor 17 by a series of bolts 18, thus forming a compact unitary structure. This unitary structure is mounted in the casing 10 on three vertical springs 19, 20 and 21. The upper ends of the springs 19, 20 and 21 are secured to feet 22, 23 and 24, respectively, these feet being welded to the periphery of the frame of the motor 17 at equally spaced intervals. A lubricant reservoir 12a is formed in the lower casing section 12 and contains a body of lubricant therein which is recirculated from the lubricant reservoir to the bearings and moving parts of the motor and the compressor during operation of the machine. Also gaseous refrigerant is confined in the upper portion of the enclosing casing 10.

As best shown in Fig. 6, the driving motor 17 has a substantially vertically disposed shaft 25 which extends above the upper end shield of the driving motor and reciprocates a compressor piston 26 in a substantially horizontal cylinder of the compressor 16 through a suitable driving connection 27. Preferably, the driving connection is of the Scotch yoke mechanism type including a crank pin 28 and a cross-head 29 slidably carried by the end of the piston 26. A counterweight 30 is disposed eccentric with respect to the center line of the vertical shaft 25 and counteracts the dynamic unbalancing affect of the crank-pin 28 and the reciprocating piston 26 upon the unitary structure comprising the compressor 16 and the driving motor 17, during operation of the machine. Intake and exhaust ports are provided in the compressor cylinder in communication with a muffle box 31 secured to the compressor 16 adjacent the outer end of the horizontal cylinder by a series of bolts 32. A cylindrical intake muffler 33 is secured to the lower end of a depending intake conduit 34, the upper end of which is secured to the muffle box 31 in communication with the intake port of the cylinder of the compressor 16. A cylindrical exhaust muffler 35 is secured to the lower end of a depending exhaust conduit 36, the upper end of which is secured to the muffle box 31 in communication with the exhaust port of the cylinder of the compressor 16. A plurality of relatively long restricted tubes 37 having return-bend portions secured in openings provided in the intake muffler 33 provides communication between the upper portion of the enclosing casing 10 and the interior of the intake muffler 33.

When the refrigerating machine is first started the body of lubricant contained in the lubricant reservoir 12a formed in the enclosing casing 10 becomes frothy and rises above its normal level in the enclosing casing due to the reduction of the pressure within the enclosing casing, causing the gaseous refrigerant absorbed in the body of lubricant to separate therefrom. Even though the body of lubricant contained in the lubricant reservoir 12a becomes frothy and rises in the enclosing casing 10 when the machine is started or any time during the operation of the machine, it cannot completely fill the enclosing casing as it will be broken up when its upper level reaches the horizontal plane of movement of the eccentrically disposed counterweight 30, indicated by the broken line 38 in the upper portion of the enclosing casing. The frothy lubricant coming into contact with the counterweight 30 is thrown outwardly in a radial direction in a thin sheet substantially in the plane indicated by the broken line 38 due to centrifugal force, which further prevents the frothy lubricant in the lower portion of the enclosing casing 10 from rising above this plane. The movement of the counterweight 30 in the plane substantially normal to the vertical shaft 25 thus suppresses frothing of the lubricant in the upper portion of the enclosing casing and establishes a zone substantially free of frothy lubricant in the upper portion of the enclosing casing above the plane indicated by the broken line 38. The inlet ends of the tubes 37 communicate with this zone in the upper portion of the enclosing casing 10 above the plane indicated by the broken line 38, thereby positively insuring that no frothy lubricant will be drawn into the intake muffler 33 along with the gaseous refrigerant during the operation of the machine.

As the piston 26 in the compressor cylinder is retracted on its suction stroke the pressure within the cylinder is reduced and gaseous refrigerant is drawn into the cylinder from the upper portion of the enclosing casing 10 through the intake muffler 33, the muffle box 31 and the intake valve of the cylinder. When the piston 26 in the compressor cylinder is moved in the opposite direction on its compression stroke the gaseous refrigerant within the cylinder is compressed and discharged through the exhaust valve of the cylinder and the muffle box 31 into the exhaust muffler 35. The compressed gaseous refrigerant passes from the exhaust muffler 35 through a conduit 39 to a condenser 40 which is cooled by natural draft and which surrounds the enclosing casing 10, the condenser having a passage 41 therein, preferably divided into upper and lower portions which are connected in series by a conduit 42. The compressed gaseous refrigerant is liquefied in the condenser 40 and flows therefrom through a conduit 43 to a suitable flow controlling float valve 44.

Liquid refrigerant is supplied from the flow controlling float valve 44 through a liquid line 45 to a sheet metal flooded type evaporator 46. The evaporator 46 is supported in the food storage compartment of the refrigerator cabinet by the heat insulated removable cabinet top 15. The liquid refrigerant contained in the evaporator 46 is vaporized by the absorption of heat from articles contained in the food storage compartment in which the evaporator is located and the vaporized refrigerant is collected in a cylindrical header 47 which is normally maintained about half full of liquid refrigerant. The vaporized refrigerant which is accumulated above the level of the liquid refrigerant in the header 47 is returned to the interior of the enclosing casing 10 through a suction conduit 48 which communicates with the header 47 above the normal liquid level therein. It will be noted that the discharge end 48a of the suction conduit 48 is located above the normal level of the body of lubricant contained in the lubricant reservoir 12a formed in the lower casing section 12 of the enclosing casing 10. The vaporized gaseous refrigerant thus discharged in the enclosing casing 10 is again drawn into the intake muffler 33 through the tubes 37 communicating with the zone substantially free of frothy lubricant in the upper portion of the enclosing casing 10, and the cycle above described is repeated until the compartment in which the evaporator 46 is located is cooled to the desired temperature. It will be noted that the upper portion of the enclosing casing 10, above the level of the body of lubricant in the lubricant reservoir 12a therein, is normally filled with low pressure gaseous refrigerant. Any gaseous refrigerant which may have been trapped in the body of lubricant while the machine is at rest will be released from this body of lubricant after the machine has run a short time and will again be mingled with the low pressure gaseous refrigerant thereabove.

Preferably, the intake muffler 33 is formed of sheet metal, one form of which is shown in Figs. 2 and 3, and comprises a series of similar casing sections secured together. In the illustrated form of the intake muffler only an upper casing section 60 and a similar lower casing 61 are shown in series, although it will be understood that any desired number of casing sections may be employed in series to obtain the muffling affect desired. Each of the casing sections is of cup-shaped configuration comprising an end wall, a cylindrical side wall and an outwardly flared open end. The outwardly flared open end 62 of

the upper casing section 60 receives the end wall 63 and firmly grips the cylindrical side wall of the lower casing section 61. The upper and lower casing section may be soldered or otherwise rigidly secured together. However, I prefer that the fit between the outwardly flared open end of the upper casing section and the cylindrical side wall of the lower casing section be sufficiently tight to hold the muffler casing in assembled relation by friction. The end wall 63 of the lower casing 61 constitutes a transverse partition in the muffler casing and is provided with a restricted passage 64 therein affording communication between upper and lower chambers 65 and 66, respectively, in the muffler casing. A plate 67 is rigidly secured in the outwardly flared open end 68 of the lower casing section 61 by brazing or the like. The end of the return-bend portion of each of the tubes 37 is secured by brazing in openings 69 provided in the plate 67. The lower end of the depending intake conduit 34 is secured by brazing in a restricted passage 70 formed in the end wall 71 of the upper casing section 60. The intake conduit 34 has an external diameter such that it may be snugly received in either of the restricted passages 70 or 64 in the upper or lower casing section 60 or 61, respectively, so that when the intake muffler is assembled any of a large number of similarly formed casing sections may be placed in any order in the series. Preferably, each of the tubes 37 is provided with an inlet end or opening 72 disposed at a relatively sharp angle with respect to the axis of the extended portion of the tube in order to minimize the whistling noises produced by the entrance of the gaseous refrigerant into the tube. Also, the end of the return-bend portion of each of the tubes 37 received in the opening 69 formed in the plate 67 is provided with an outlet end or opening 73 disposed at a relatively sharp angle with respect to the axis of the return-bend portion of the tube in order to further minimize the whistling noises produced by the gaseous refrigerant emerging from the tube into the lower chamber 66 in the muffler casing.

A restricted aperture 74 is provided in the plate 67 which affords communication between the lower chamber 66 in the muffler casing and the interior of the enclosing casing 10 to provide for the escape from the lower chamber 66 of any lubricant accumulating therein, and to allow this lubricant to be drained back into the lubricant reservoir 12*a* formed in the lower casing section 12. The area of the restricted aperture 74 is small as compared to the area of the tubes 37 in order to insure that the pressure drop through the restricted aperture 74 is relatively great as compared to the pressure drop through the tubes 37. This arrangement insures that substantially no gaseous refrigerant will be drawn into the lower chamber 66 of the muffler casing through the restrictive aperture 74, yet lubricant accumulating therein will be permitted to escape.

The arrangement and construction of the intake muffler as above described is described and claimed in my copending application, Serial No. 161,075, filed August 26, 1937, which is a division of the present case.

During the operation of the refrigerating machine gaseous refrigerant is drawn into the lower chamber 66 of the intake muffler 33 from the zone substantially free of frothy lubricant in the upper portion of the enclosing casing 10 through the relatively long restricted tubes 37 having return-bend portions. The gaseous refrigerant then flows from the lower chamber 66 through the restricted passage 64 formed in the end wall 63 of the lower casing section 61 into the upper chamber 65 of the muffler casing. The gaseous refrigerant is then drawn from the upper chamber 65 through the depending intake conduit 34 into the muffle box 31 and the intake of the compressor 16. Any lubricant gaining entrance into the muffler casing 33 will escape through the restricted aperture 74 provided in the plate 67 and be drained back into the lubricant reservoir 12*a*.

In an intake muffler such as I have illustrated in Figs. 2 and 3, designed for use in conjunction with a sulphur dioxide refrigerant compressor, two tubes 37 should be employed to conduct gaseous refrigerant into the muffler casing 33. Each of the tubes should have a return-bend portion and an overall length approximately 50 times the internal diameter thereof so that an extended reverse-flow muffling path of restricted cross-section is formed between the inlet and outlet ends of the tube. The columns of gaseous refrigerant in these tubes have a sufficiently high inertia that the energy of the wave motion set up in the gaseous refrigerant within the depending intake conduit 34 and the chambers 65 and 66 in the muffler casing is substantially all dissipated in moving such columns of gaseous refrigerant. The volume of the muffler chambers 65 and 66 should be relatively large as compared to that of the tubes 37, both the internal diameter and the height of each of the chambers being of the order of 9 times the internal diameter of the tubes 37. Also, the volume of the muffler casing should be somewhat larger than the volumetric displacement of the piston in the cylinder of the compressor in order to provide a reserve supply of gaseous refrigerant in the muffler casing thereby minimizing the surges of gaseous refrigerant into the compressor on the suction stroke and the accompanying vibratory disturbances.

In Figs. 4 and 5 I have shown a modified form of the intake muffler 33 comprising complementary upper and lower casing sections 80 and 81, respectively, of substantially cup-shaped configuration. The upper casing section 80 is provided with an outwardly flared open end 82 and the lower casing section 81 is provided with an inwardly flared open end 83, the inwardly flared open end 83 being received and firmly gripped within the outwardly flared open end 82. These casing sections may be brazed or otherwise rigidly secured together. However, I prefer that the fit between the outwardly flared open end 82 and the inwardly flared open end 83 be sufficiently tight to hold the muffler casing in assembled relation by friction. A transverse partition 84 is arranged in the upper casing section 80 in abutting relationship with the inwardly flared open end 83 of the lower casing section 81. The partition 84 is provided with a restricted passage 85 therein forming communicating upper and lower chambers 86 and 87 in the muffler casing. The end wall 88 of the upper casing section 80 is provided with two spaced apart openings 89 in vertical alignment with two spaced apart openings 90 provided in the transverse partition 84 through which two relatively long restricted tubes 91 are inserted into the muffler casing. Each of the tubes 91 extends through the end wall 88 of the upper casing section 80, the upper chamber 86, and the transverse partition 84 into the lower chamber 87. The tubes 91 are of suf-

ficient length so as to communicate with the zone substantially free of frothy lubricant in the upper portion of the enclosing casing 10, when the intake muffler illustrated in Figs. 4 and 5 is employed in the refrigerating machine. Preferably, each of the tubes 91 is provided with an inlet end or opening 92 disposed at a relatively sharp angle with respect to the axis of the tube and an outlet end 93 disposed adjacent the end wall 94 of the lower casing section 81. The lower end of the depending intake conduit 34 is secured in an opening 95 provided in the end wall 88 of the upper casing section 80.

The end wall 94 of the lower casing section 81 is provided with a centrally disposed and inwardly extending indentation 96 which defines an annular reservoir 97 in the end wall 94. A restricted aperture 98 is provided in the inwardly extending indentation 96 which affords communication between the lower chamber 87 and the interior of the enclosing casing 10 to provide for the escape from the lower chamber 87 of any lubricant accumulated therein, and to permit this lubricant to be drained back into the lubricant reservoir 12a formed in the lower casing section 12. It will be observed that the lower ends 93 of the tubes 91 are arranged out of alignment with the restricted aperture 98 provided in the inwardly extending indentation 96 to prevent the gaseous refrigerant emerging from the outlet ends 93 of the tubes 91 from interfering with the escape of lubricant accumulating in the annular reservoir 97 through the restricted aperture 98. The area of the restricted aperture 98 is small as compared to the area of the tubes 91 in order to insure that the pressure drop through the restricted aperture 98 is relatively great as compared to the pressure drop through the tubes 91. This arrangement insures that substantially no gaseous refrigerant will be drawn into the lower chamber 87 of the muffler casing through the restricted aperture 98, yet lubricant accumulating therein will be permitted to escape.

During the operation of the refrigerating machine gaseous refrigerant is drawn into the lower chamber 87 of the intake muffler from the zone substantially free of frothy lubricant in the upper portion of the enclosing casing 10 through the relatively long restricted tubes 91. The gaseous refrigerant flows from the lower chamber 87 through the restricted passage 85 formed in the transverse partition 84 into the upper chamber 86 of the muffler casing. The gaseous refrigerant is then drawn from the upper chamber 86 through the depending intake conduit 34 into the muffle box 31 and the compressor 16. Any lubricant gaining entrance into the muffler casing 81 escapes through the restricted aperture 98 provided in the inwardly extending indentation 96 and is drained back into the lubricant reservoir 12a.

In an intake muffler such as I have illustrated in Figs. 4 and 5, designed for use in conjunction with a sulphur dioxide refrigerant compressor, two tubes 91 should be employed to conduct gaseous refrigerant into the muffler casing. Each of the tubes should have an overall length approximately 40 times the internal diameter thereof so that an extended muffling path of restricted cross-section is formed between the inlet and outlet ends of the tube. Also, the outlet ends of the tubes should extend into the muffler casing in close proximity to the end wall 94 of the lower casing section 81 so that the end wall serves as a baffle for the gaseous refrigerant emerging from the tubes to reverse the direction of flow thereof. The columns of gaseous refrigerant in these tubes have a sufficiently high inertia that the energy of the wave motion set up in the gaseous refrigerant within the depending intake conduit 34 and the chambers 86 and 87 in the muffler casing is substantially all dissipated in moving such columns of gaseous refrigerant. The volume of the muffler chambers 86 and 87 should be relatively large as compared to that of the tubes 91, the internal diameter of each of the chambers being of the order of 9 times the internal diameter of the tubes 91 and the overall height of the two chambers being approximately twice the diameter of the chambers. Also, the volume of the muffler casing should be somewhat larger than the volumetric displacement of the piston in the cylinder of the compressor in order to provide a reserve supply of gaseous refrigerant in the muffler casing thereby minimizing the surges of gaseous refrigerant into the compressor on the suction stroke and the accompanying vibratory disturbances.

While I have shown a particular embodiment of my invention in connection with a household type of refrigerating machine, I do not desire my invention to be limited to the particular construction shown and described, and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A refrigerating machine comprising a compressor, a motor for driving said compressor, an enclosing casing for said compressor having a lubricant reservoir in the lower portion thereof containing a body of lubricant and gaseous refrigerant in the upper portion thereof, means for establishing a zone in the upper portion of said enclosing casing substantially free of any frothy lubricant present in said enclosing casing, an intake muffler for said compressor, means including an inlet opening arranged in said zone for conducting gaseous refrigerant from said zone to said muffler, and means for conducting gaseous refrigerant from said muffler to said compressor.

2. A refrigerating machine comprising a compressor, a motor for driving said compressor, an enclosing casing for said compressor having a lubricant reservoir in the lower portion thereof containing a body of lubricant and gaseous refrigerant in the upper portion thereof, means operated by said motor for establishing a zone in the upper portion of said enclosing casing substantially free of any frothy lubricant present in said enclosing casing, an intake muffler for said compressor, means including an inlet opening arranged in said zone for conducting gaseous refrigerant from said zone to said muffler, and means for conducting gaseous refrigerant from said muffler to said compressor.

3. A refrigerating machine comprising a vertical shaft motor, a compressor having a cylinder supported on top of said motor, an enclosing casing for said motor and said compressor having a lubricant reservoir in the lower portion thereof containing a body of lubricant and gaseous refrigerant in the upper portion thereof, means including an eccentric counter-weight carried by the upper portion of said shaft for counteracting dynamic unbalance of said compressor and for establishing a zone in the upper portion of said enclosing casing substantially free of any frothy

lubricant present in said enclosing casing, an intake muffler for said compressor, means including a relatively long restricted tube having an inlet opening arranged in said zone for conducting gaseous refrigerant from said zone to said muffler, and means including a conduit for conducting gaseous refrigerant from said muffler to said compressor cylinder.

4. A refrigerating machine comprising a compressor, a motor for driving said compressor, an enclosing casing for said compressor having a lubricant reservoir in the lower portion thereof containing a body of lubricant and gaseous refrigerant in the upper portion thereof, means operated by said motor for establishing a zone in the upper portion of said enclosing casing substantially free of any frothy lubricant present in said enclosing casing, an intake muffler for said compressor arranged in said enclosing casing, means including an inlet opening arranged in said zone for conducting gaseous refrigerant from said zone to said muffler, a restricted aperture in said muffler and arranged to provide for the escape from said muffler of any lubricant accumulating therein, and means for conducting gaseous refrigerant from said muffler to said compressor.

5. A refrigerating machine comprising a compressor, a motor for driving said compressor, an enclosing casing for said compressor and said motor having a lubricant reservoir formed in the lower portion thereof containing a body of lubricant and gaseous refrigerant in the upper portion thereof, means operated by said motor for establishing a zone in the upper portion of said enclosing casing substantially free of any frothy lubricant present in said enclosing casing, an intake muffler for said compressor arranged in said enclosing casing, said muffler having a casing, means constituting a transverse partition in said muffler casing and provided with a restricted passage therein forming a plurality of communicating chambers in said muffler casing, a relatively long restricted tube having an inlet opening arranged in said zone for conducting gaseous refrigerant from said zone to one of said chambers in said muffler, a restricted aperture in said muffler casing and arranged to provide for the escape from said muffler casing of any lubricant accumulating therein, and a conduit for conducting gaseous refrigerant from another of said chambers in said muffler casing to said compressor.

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