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Potter et al.

[11] **3,722,187**

[45] **Mar. 27, 1973**

[54] **LIQUID AND GAS SEPARATING ASSEMBLY**

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[73] Assignee: **Worthington Corporation,** Harrison, N.J.

[22] Filed: **Aug. 21, 1970**

[21] Appl. No.: **65,771**

Related U.S. Application Data

[62] Division of Ser. No. 809,187, March 21, 1969, Pat. No. 3,588,288.

[52] **U.S. Cl.** **55/323,** 55/337, 55/430, 55/437, 184/6.16, 417/313

[51] **Int. Cl.** **B01d 50/00**

[58] **Field of Search**.....55/319, 437, 321, 323, 333, 55/430, 432, 337; 62/470–473; 210/416; 417/313; 184/6.16

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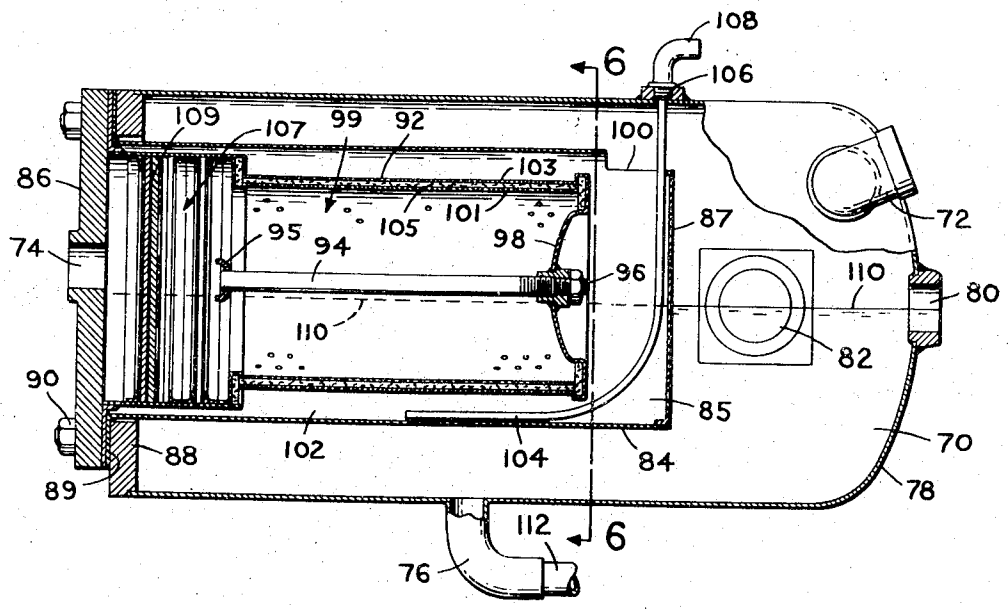
[57] **ABSTRACT**

A liquid and gas separating assembly for an air compressor. The assembly includes an outer shell, an inner shell within the outer shell and a liquid-gas separating element within the inner shell. A gas laden with liquid particles, such as oil laden air from an air compressor, is admitted to the outer shell in which a large amount of the entrained liquid settles out of the gas into a pool of stored liquid partially submerging the inner shell in the lower portion of the outer shell. The gas passes into the inner shell through an inlet above the pool of liquid and then through the liquid-gas separating element. The separated gas and liquid are removed from the two shells through different outlets.

8 Claims, 7 Drawing Figures



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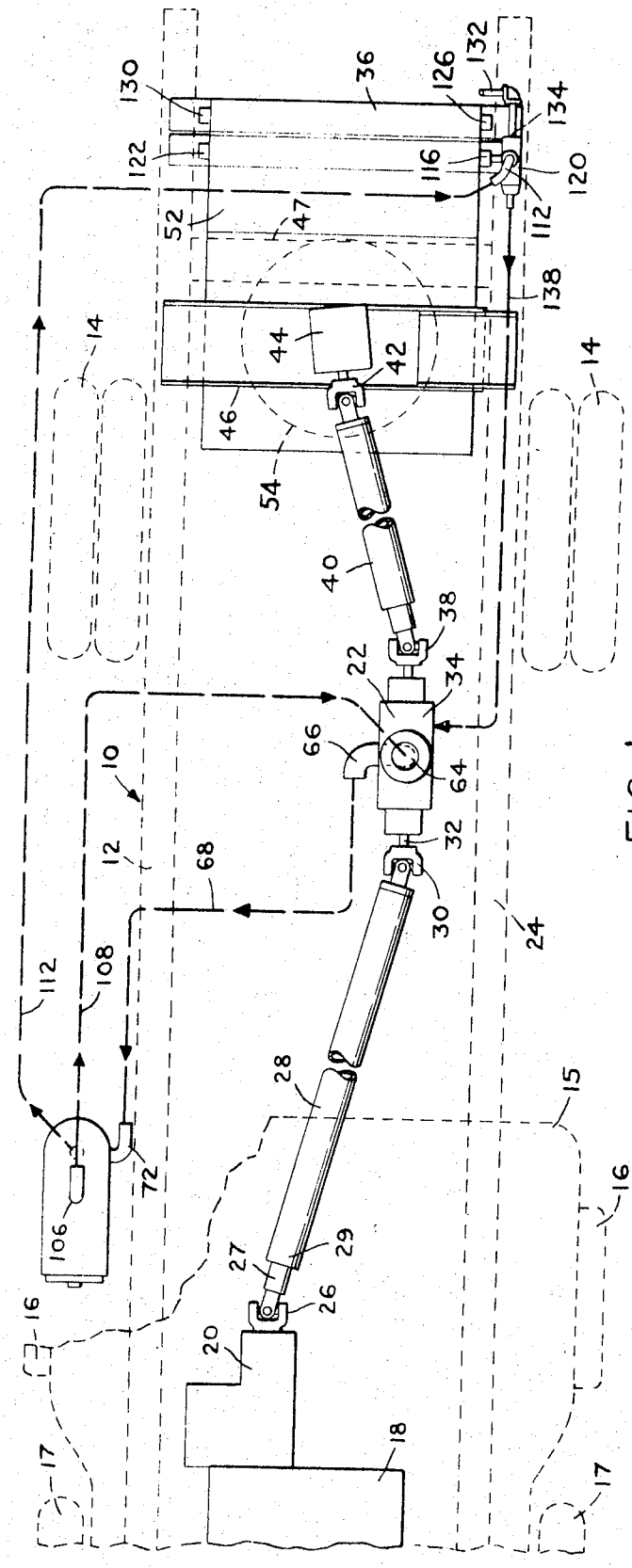

FIG. 1

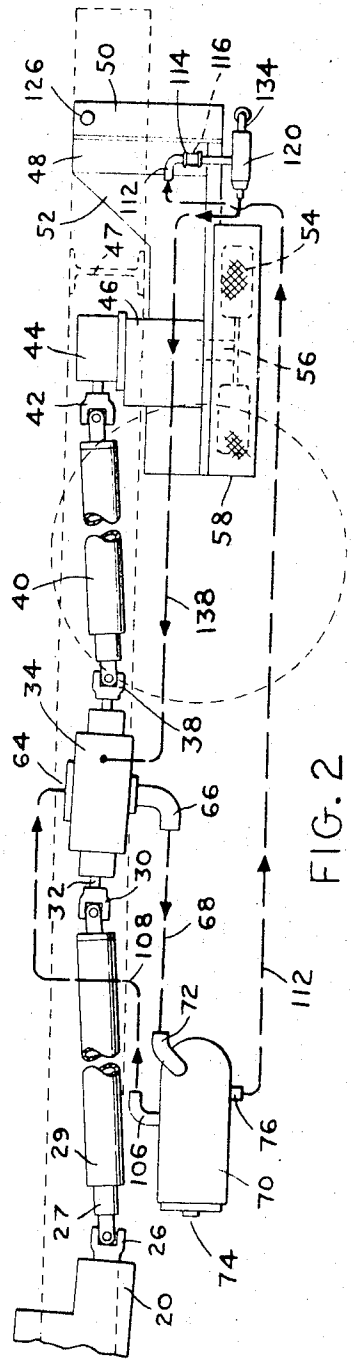

FIG. 2

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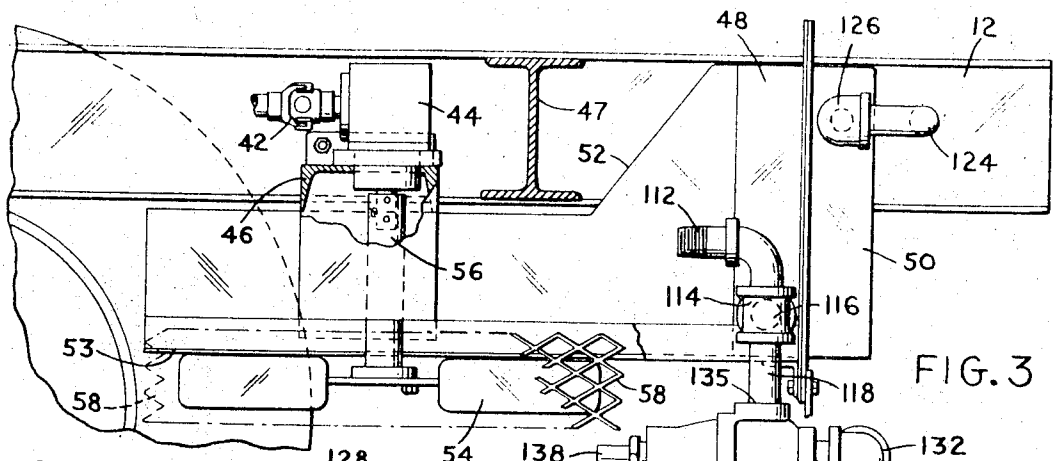

FIG. 3

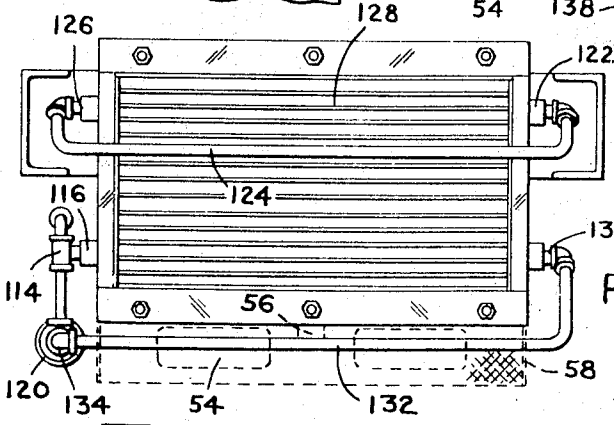

FIG. 4

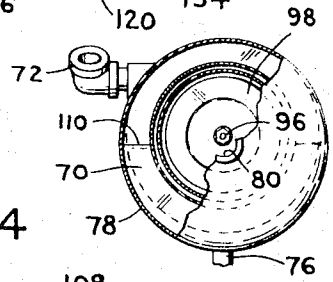

FIG. 6

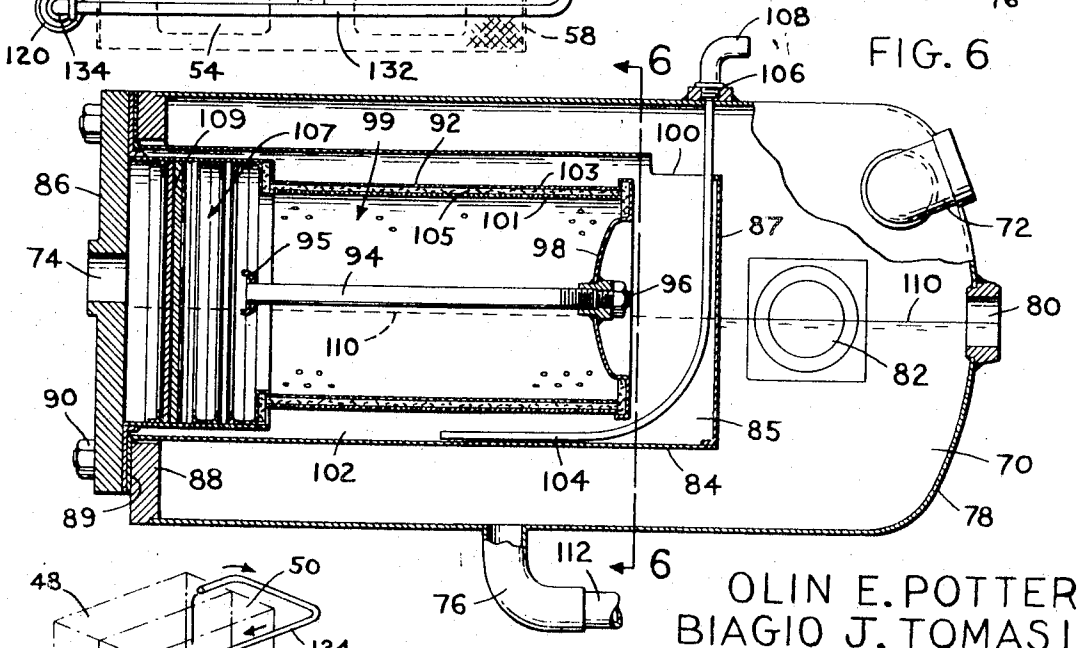

FIG. 5

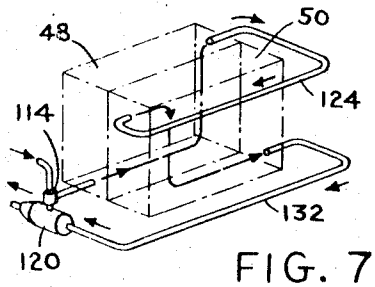

FIG. 7

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LIQUID AND GAS SEPARATING ASSEMBLY

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a division of U.S. Pat. application Ser. No. 809,187, filed Mar. 21, 1969 now U.S. Pat. No. 3,588,288 issued June 28, 1971.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a liquid-gas separator for a compressor assembly.

2. Description of the Prior Art

Compressor systems have often been mounted on motor vehicles and driven by the vehicle engine. However, these vehicle mounted compressor systems have presented problems which have reduced the usefulness of the vehicle or the compressor or both. Many of these problems relate to the cooling system for the compressor. A separate compressor cooling system is preferable to a dual purpose cooling system which cools both the vehicle engine and the compressor.

Such dual purpose cooling systems have proven to be relatively inefficient because of the several compromises which must be made in the design of the system to provide the extra cooling capacity to cool the compressor in addition to the vehicle engine.

An example of such a compromise is shown in U.S. Pat. No. 1,255,632 issued to L. Poccia on Feb. 5, 1918 in which a separate radiator member 41 for cooling compressor 30 is mounted and disposed behind radiator 13 for the vehicle engine 11. However, the fan 14, disposed between the two cores of the engine radiator must be oversized so that enough air will be drawn through radiator cores 13 to cool the engine without unduly raising the temperature of the cooling air, since the temperature of the air after passing through engine radiator 13 must be low enough and the quantity of air great enough to affect the required heat transfer to cool the compressor when the air subsequently passes through auxiliary radiator 41.

Separate cooling systems for a vehicle mounted compressor include a separate radiator, fan and means to drive the fan. This equipment is usually bulky and complex and therefore prone to failure. Additionally, the mounting requirements to obtain efficient performance of the radiator and the fan drive often make it necessary to sacrifice valuable working space in the vehicle. A further complication has been presented by the relatively unwieldly size and shape of the compressor oil-air separators of the prior art.

Accordingly, an object of the present invention is to provide an improved air receiver-oil separator tank for a vehicle mounted compressor system which receives an air oil mixture from the compressor discharge and separates the oil from the compressed air and separately stores the oil and the compressed air.

Still a further object of the present invention is to provide an air receiver-oil separator tank of reduced volume suitable for a vehicle mounted compressor system.

Yet another object of the present invention is an air oil separating and storage tank for a vehicle mounted compressor system in which the air oil separating element is disposed at least partially below the oil level in the tank.

SUMMARY OF THE INVENTION

In accordance with the present invention the oil and compressed air from the discharge of a vehicle mounted compressor are separated and stored in a single horizontally disposed tank. The separator assembly of the invention includes an outer shell, an inner shell within the outer shell and a liquid-gas separating element within the inner shell. A gas laden with liquid particles, such as oil laden air from an air compressor, is admitted to the outer shell and a large amount of the entrained liquid will be settled out of the gas into a pool of stored liquid which partially submerges the inner shell. The gas passes into the inner shell through an inlet disposed above the pool of liquid and thence through the liquid-gas separating filter element. The separated gas and liquid are removed from the two shells through different outlets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic in plan view of a compressor system mounted on a truck frame.

FIG. 2 is a side view of FIG. 1.

FIG. 3 is a side view in section of the oil cooling assembly of the system of FIG. 1.

FIG. 4 is a rear end view of the oil cooling assembly of FIG. 3.

FIG. 5 is a side view in section of the receiver-demister tank assembly of the present invention mounted in the compressor system of FIG. 1.

FIG. 6 is a rear end view partly in section of FIG. 5.

FIG. 7 is a schematic representation of the flow path through the cooling unit of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 show in phantom lines a standard industrial truck generally indicated at **10** having a commonly available ladder type truck frame **12**, a standard rear wheel assembly **14**, the usual drivers compartment **15** and running boards **16** and front wheel assembly **17**. The engine of the truck **18** has a power take-off connection **20** which drives a rotary compressor **22** by means of a commonly known automotive type drive shaft assembly consisting of a splined drive shaft **28** having an externally splined section **27** axially slidably engaged with an internally splined hollow tubular section **29**, the drive shaft **28** being connected at one end to the power take-off connection **20** by universal joint **26**, and at the other end connected to the rotor shaft **32** of compressor **22** by a power receiving universal joint **30**. The compressor **22** can be attached to the side rail **24** by any convenient method of attachment as for example by the use of a suitable bracket or fastening strap, not shown. The compressor rotor shaft **32** extends through the compressor housing **34** and drives the compressor cooler assembly generally indicated at **36** through a second automotive drive assembly consisting of a splined drive shaft **40** connected at one end to a right angle gear box **44** which provides power for the compressor cooler assembly.

The oil cooler assembly **36** is mounted from a cross brace **46** connected at each end to the side rails **24** of the truck ladder frame **12**. The cooler assembly consists of series-connected first and second cooling cores **48** and **50** respectively, and a horizontally disposed fan

54 driven by shaft 56 extending from right angle gear box 44. A shroud member 52 is disposed about the first and second cooling cores and the fan 54, with the fan rotating in a plane slightly below the bottom 53 of the shroud. The shape of the shroud 52 and the positioning of the fan 54 with respect to the shroud cause the fan, when operating, to draw air through the first and second cooling cores and exhaust the air downwardly towards the ground and radially outward. A shield 58 for the fan protects against accidental injury from the fan blades 54.

The compressor 22 has an inlet 64 and a discharge outlet 66 which is connected by suitable conduit means, designated by dashed lines 68, to the inlet 72 of an air receiver-oil separator tank 70. As shown in FIGS. 5 and 6 the air receiver-oil separator tank 70 consists of an outer housing 78 with the inlet 72 mounted in the upper portion thereof, a compressed air discharge outlet 74 in the removable cover 86 and an oil outlet 76 in the bottom of the outer housing. An oil filler neck (not shown) attaches to opening 80 at the end of the housing and an oil level gauge 82 is located in the side of the housing to indicate the oil level 110 in the tank. The majority of the oil in the compressor discharge is separated from the compressed air upon entry through inlet 72 into the outer housing and falls to the bottom of the outer housing usually rising to the level 110 as shown in FIG. 5. A closed oil tight chamber 84 partially submerged in the oil within the outer housing is formed from a cylindrical member 85, closed at one end by a wall 87 and with a flange portion 89 at the other end, which flange is secured between the end cover 86 for the outer housing 78 and a bolting flange 88 on the outer housing 78 to which the end cover is fastened by a plurality of bolts 90. An air-oil separating element 92 is mounted within oil tight chamber 84 by means of a mounting rod 94 extending from an anchoring member 95 axially through the separating element and secured by mounting bolt 96 which presses against retaining member 98. The air-oil separating element includes a first cylindrical section generally indicated at 99 having perforated inner and outer walls 101 and 103 respectively enclosing a filtering material 105. A second cylindrical section generally indicated at 107 contains a plurality of discs of filtering material generally indicated at 109 disposed perpendicularly to the axis of the air oil separating element 92.

An opening 100 in the top of oil tight chamber 84 allows compressed gas from the compressor discharge in outer housing 78 to enter the closed oil tight chamber and then pass through the air-oil separator element 92 wherein any oil remaining in the compressed gas will be separated out. The separated oil falls to the bottom section 102 of the oil tight chamber where it is drawn off by means of a siphon tube 104 which extends from the bottom section 102 of the oil tight chamber through opening 100 and out an opening 106 in the outer housing 78. The oil then passes by means of conduit 108 to an area of lower pressure to be more fully explained below.

A conduit shown as a dotted line 112 connects oil outlet 76 of air receiver-oil separator tank 70 to the inlet of a T-fitting 114 having one outlet connected to the inlet 116 of the first cooling core 48 and the second outlet connected by conduit 118 to a thermostatic valve 120 whose function will be explained later. As seen in FIGS. 3, 4 and 7 the oil entering inlet 116 of first cooling core 48 passes through the core and exits from outlet 122 and then is carried by conduit 124 to the inlet 126 of the second cooling core 50. The oil passes through the coils 128 of core 50, exits through outlet 130 and then is carried by conduit 132 to the second inlet 134 of thermostatic valve 120. The oil leaves thermostatic valve 120 passing from outlet 136 to conduit 138 which carries the oil back to compressor housing 34 where the oil is used to cool the compressor and provide sealing for operation of the compressor.

An alternate flow path for the oil in conduit 112 can be established by changing the setting of thermostatic valve 120. If this valve is set to allow communication between the first inlet 135 and the outlet 136, the oil will bypass the cooling cores 48 and 50 and flow directly back to the compressor.

Conduit 108 connects siphon tube 104 to the inlet of the compressor to provide the source of lower pressure in order to siphon off the scavenged oil in the bottom section 102 of the closed oil tight chamber.

OPERATION

The construction of the invention set forth herein provides for efficient operation of the entire compressor system. Power for the compressor 22 is obtained from the vehicle engine 18 through the power take-off connection 20 on the engine and transmitted through the splined shaft 28 to the compressor rotor shaft 32. The rotary compressor shaft in turn provides power through splined shaft 40 to power the fan of the compressor cooler assembly. It should be apparent therefor that the fan of the compressor cooler assembly operates only when the rotary compressor is in operation. The compressor discharges through outlet 66 and conduit 68 into the inlet 72 of the air oil receiver-oil separator tank 70. Oil from the tank passes through conduit 112 to the T-fitting 114 which leads to either the inlet 116 of the first cooling core 48 or to the thermostatic valve 120.

If the coil is cold because the compressor has just started operation the thermostatic valve will position itself to communicate inlet 135 with outlet 136 thereby by-passing the cooling cores. As the compressor continues to operate the temperature of the oil rises and the thermostatic valve 120 will position itself to block off inlet 135 and to communicate inlet 134 with outlet 136 thereby establishing a flow path from the air receiver-oil separator tank 70 through the first and second cooling cores and then back to the compressor.

The oil cooling assembly is constructed to provide maximum efficiency. The first and second cooling cores are arranged in series to provide for a counter current flow through the cores thereby providing maximum cooling efficiency by maintaining, as near as possible a constant temperature difference between the temperature of the oil to be cooled in the cores and the cooling air passing through the coils. To be specific, the air entering the first cooling core 48 has already been heated as it passed through the second cooling coil 50 and this warmed air cools the uncooled oil coming directly from the air receiver-oil separator tank. Similarly, oil entering the second cooling core 50 has been partially cooled in the first cooling core and is

further cooled by the unheated air which is being drawn from the atmosphere through the second cooling core. It should be mentioned, of course, that two cooling cores are not critical to the function of the compressor system. A cooling system using one or three cooling cores would also be operable.

The positioning of the fan **54** to rotate in the horizontal plane and outside shroud **52** provides several advantages. Of primary importance is a considerable saving of space. The fan can now be mounted below the frame of the truck and does not take up any useful working space on the truck frame. In order for the horizontal fan to effectively draw air through the vertical first and second cooling cores it is necessary to surround the entire compressor cooler assembled with shroud **52**. The shroud changes the direction of the air flow produced by the fan from horizontal as it passes the cooling cores to vertically downward as it approaches the fan **54**. Because the fan rotates in a plane below the shroud, it imparts a large radial velocity component to the air it exhausts, thereby preventing a strong exhaust downdraft. Such downdrafts are undesirable since they cause large amounts of dust to be raised when the compressor system is working in certain environments. Additionally, by placing the cooling cores vertically between the rails **24** of the truck frame **12**, the cores are provided maximum protection from damage due to road debris thrown up during over the road operation. Further, facing the cooling cores rearward prevents hot engine exhaust air from being drawn into the cooling cores by the fan, thereby eliminating the possible loss of cooling efficiency that would occur if the engine exhaust were drawn through the cooling cores.

Mention should be made of the advantages in construction of the air receiver-oil separator tank **70**. Because the tank is of small diameter and mounted horizontally it can be easily positioned anywhere under the truck frame, for example under the running board **16** as shown in FIG. **1**. However, because of the horizontal position and its small diameter the oil level in the tank is higher than the lowest point of the air-oil separator element. For this reason, the air oil separating element is placed within the oil tight container **84** within the tank and the inlet **100** to this oil tight container is at the top thereof to prevent any flow of accumulated oil into the oil separator filter element **92**. Since the pressure in the air receiver-oil separator tank **70** is approximately equal to the discharge pressure of the compressor any oil which has been separated by the oil separator element **92** and has accumulated in the bottom section of the oil tight chamber **84** can be easily removed by means of the siphon tube **104** which in turn is connected through conduit **108** to the inlet **64** of the compressor **22** where the oil is productively used.

What is claimed is:

1. A liquid and gas separating assembly for a compressor comprising:

outer shell means having end and side walls which define a storage container for the accumulation of liquid, said outer shell means being provided with a liquid-gas mixture inlet port for receiving and directing into said outer shell means the discharge from a compressor, said outer shell means further having liquid and gas discharge ports, said mixture inlet port being disposed at a level displaced vertically above said liquid discharge port and said gas discharge port being disposed at a level vertically intermediate said mixture inlet and liquid discharge ports;

inner shell means having end and side walls which define a liquid impervious container, said inner shell means being mounted within said outer shell means so as to be partially submerged in liquid accumulated in said outer shell means, said inner shell means being provided with a mixture inlet communicating with the interior of said outer shell means at a vertical level above the level to which the liquid is permitted to accumulate, said inner shell means further being provided with a gas discharge port which communicates with and is sealed to said outer shell means gas discharge port;

liquid-gas filter separator means disposed within said inner shell means between said inner shell means mixture inlet and gas discharge ports for separating liquid from gas and passing said gas to said gas discharge ports; and

conduit means for removing liquid separated by said separator means from the mixture delivered to said inner shell means, said conduit means extending continuously from the vicinity of the vertically lowest region of said inner shell means through a wall of said outer shell means and being connected to the compressor at the suction inlet thereof whereby continuous scavenging of liquid from the inner shell means will occur when the compressor is operating.

2. The combination claimed in claim **1** wherein:

said outer shell means is comprised of a generally cylindrical member having one removable end wall;

the gas outlet port of said outer shell means is disposed in said removable end wall; and

said inner shell means is mounted from said removable end wall.

3. The combination claimed in claim **2** wherein said outer shell means liquid discharge port is disposed at the bottom of said outer shell means, the combination further comprising:

a liquid filler nozzle in said outer shell means, said liquid filler nozzle being disposed at a vertical level intermediate said outer shell means mixture inlet and liquid discharge ports; and

a liquid level sight gauge in said outer shell means.

4. The apparatus of claim **3** wherein said separator means comprises:

first filter means mounted in said inner shell means adjacent to said outer shell means gas discharge port; and

second filter means mounted in said inner shell means between said first filter means and said mixture inlet port, said second filter means being oriented generally coaxially of said gas discharge ports and transversely of said first filter means.

5. The apparatus of claim **4** wherein said outer shell means mixture inlet port is disposed above the level of the liquid accumulated in said outer shell and discharges parallel to the upper surface of said liquid and generally tangentially to said outer shell cylindrical member.

6. The combination claimed in claim 1 wherein said outer shell means liquid discharge port is disposed at the bottom of said outer shell means, the combination further comprising:

a liquid filler nozzle in said outer shell means, said liquid filler nozzle being disposed at a vertical level intermediate said outer shell means mixture inlet and liquid discharge ports; and

a liquid level sight gauge in said outer shell means.

7. The apparatus of claim 6 wherein said outer shell means mixture inlet port is disposed above the level of the liquid accumulated in said outer shell and discharges parallel to the upper surface of said liquid and generally tangentially to said outer shell cylindrical member.

8. The apparatus of claim 1 wherein said separator means comprises:

first filter means mounted in said inner shell means adjacent to said outer shell means gas discharge port; and

second filter means mounted in said inner shell means between said first filter means and said mixture inlet port.

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