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(54) **AIR COMPRESSOR PRE-LUBRICATION SYSTEM**

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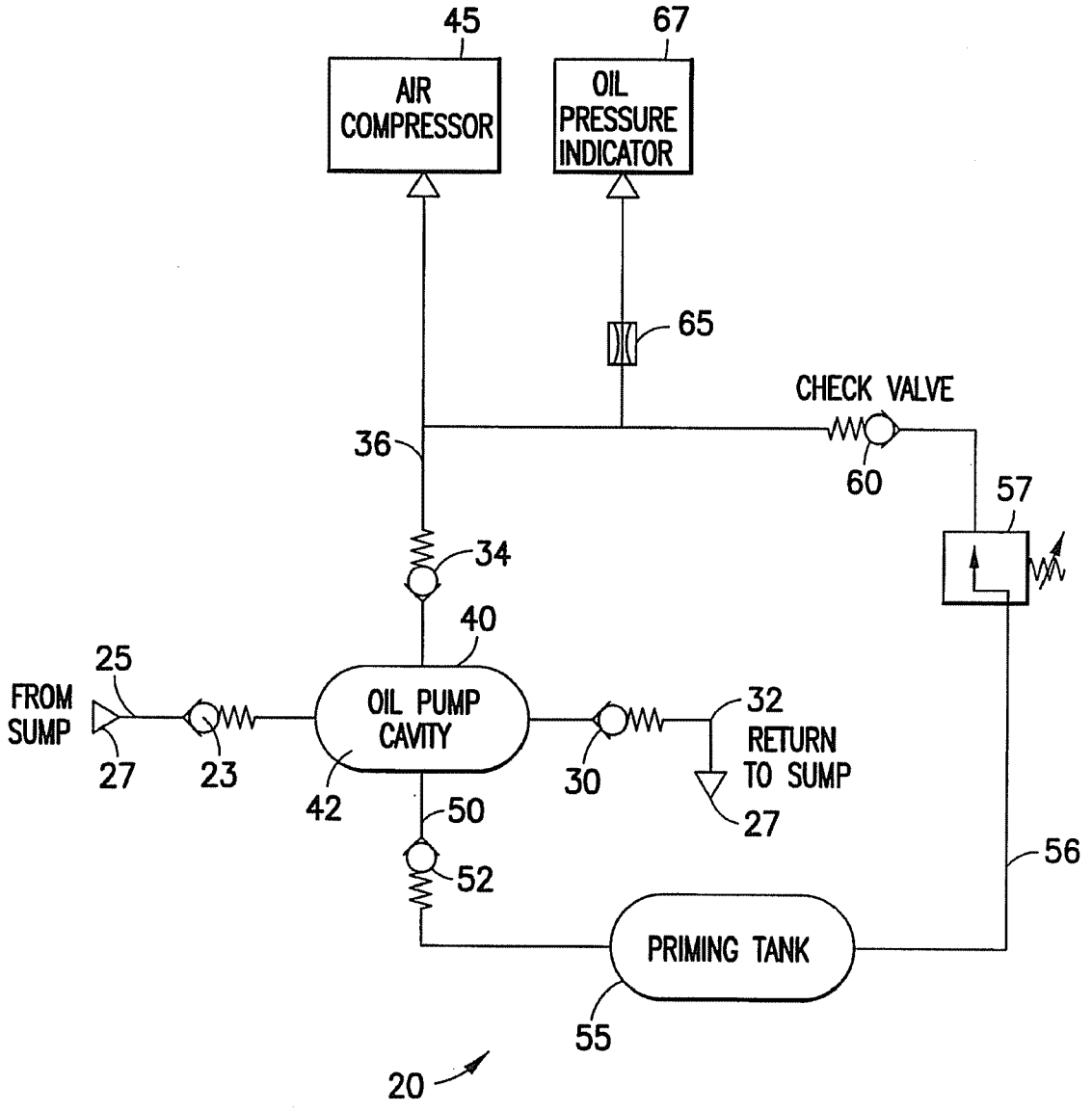
(57) **ABSTRACT**

The air compressor pre-lubrication system includes an oil pump, a priming tank, and a control valve. The oil pump is connected to an oil sump and includes a discharge line connected to an air compressor. The priming tank is connected to the oil pump to receive pressurized oil. The control valve is provided in an outline line connected to the priming tank and is further connected to the oil pump discharge line. The priming tank is configured to maintain a charge of oil from the oil pump and selectively release the charge of oil through actuation of the control valve. An auxiliary pre-lubrication oil pump may replace the priming tank. The pre-lubrication oil pump is connected to the oil sump and is fluidly coupled to the discharge line leading to the air compressor.



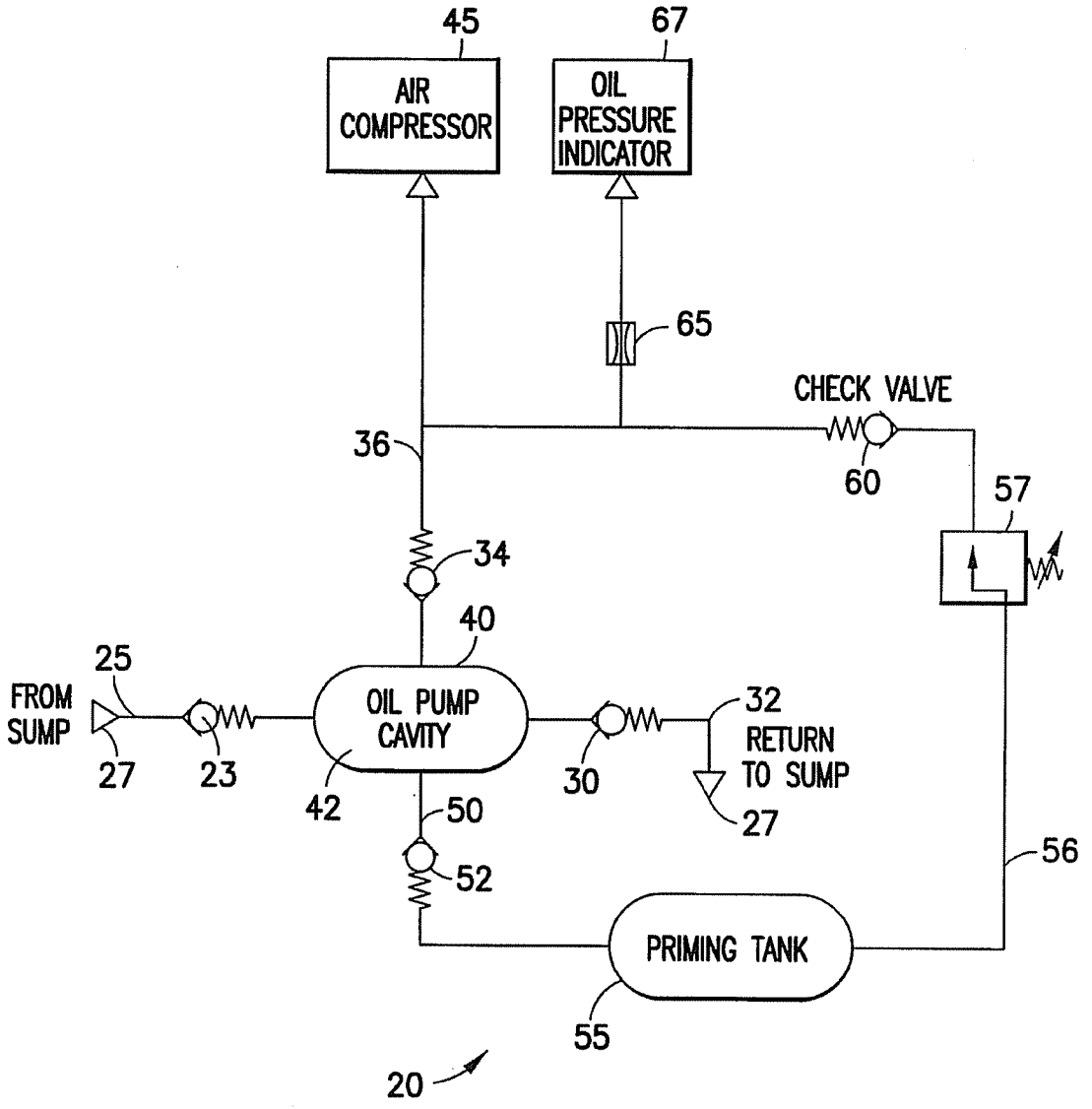
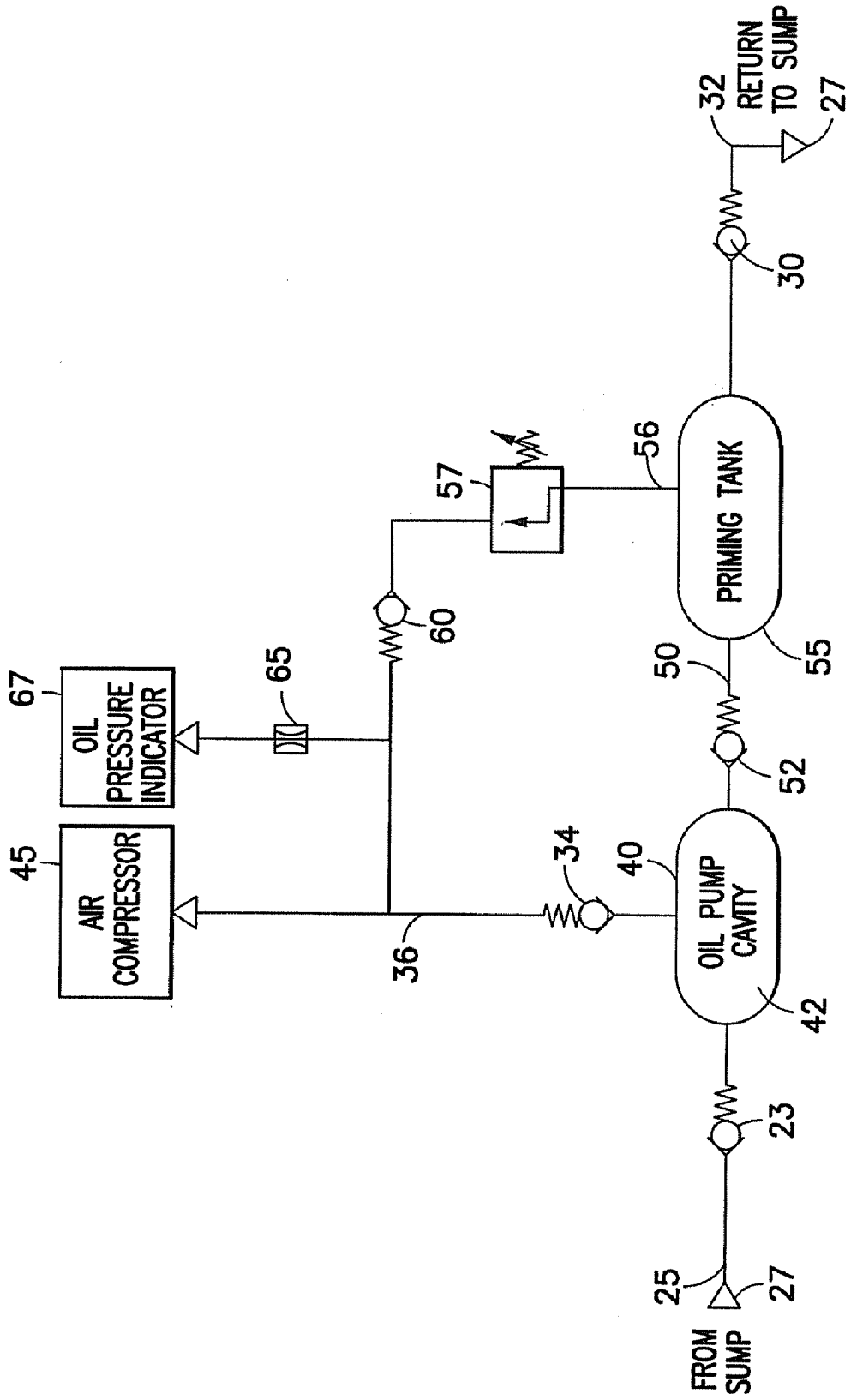

45
67
AIR COMPRESSOR
OIL PRESSURE INDICATOR
65
CHECK VALVE
36
60
57
34
40
25
FROM SUMP
OIL PUMP CAVITY
32
RETURN TO SUMP
27
23
42
30
27
50
52
56
PRIMING TANK
55
20

FIG. 1


FROM SUMP
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AIR COMPRESSOR
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OIL PRESSURE INDICATOR
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PRIMING TANK
56
55
50
52
RETURN TO SUMP
32
27
30
20

FIG.2

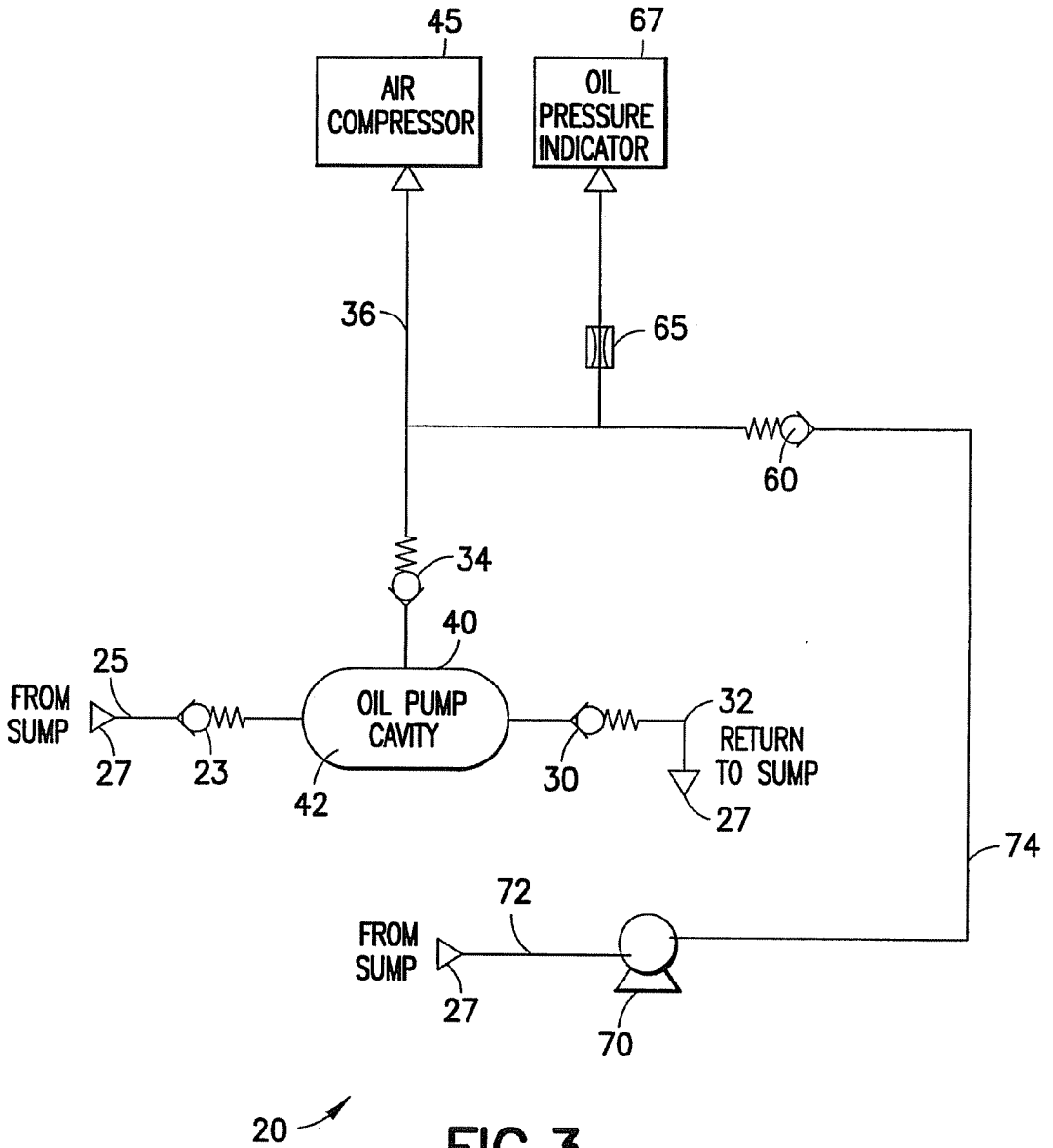
45
AIR COMPRESSOR
67
OIL PRESSURE INDICATOR
36
65
60
34
40
25
FROM SUMP
27
23
OIL PUMP CAVITY
42
30
32
RETURN TO SUMP
27
74
72
FROM SUMP
27
70
20

FIG.3

AIR COMPRESSOR PRE-LUBRICATION SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an air compressor and, more particularly, to a pre-start lubrication system for an air compressor.

[0003] 2. Description of Related Art

[0004] Often during startup of a compressor there is a period of time that the lubrication system of the compressor will not have full pressure. In particular, when the compressor is shut down, the oil pressure within the compressor quickly bleeds back to an oil sump. With the passageways of the lubrication system emptied of oil, when the compressor is restarted, it will run without lubrication or with partial lubrication for a period of time until the passages are once again filled and pressurized. This period of time will vary based on several factors.

[0005] Many compressors were originally designed for continuous operation. However, since the addition of electric motor drive, start/stop operation has become the standard method of control. For compressor applications where hundreds of starts may be required each month, the accumulated result of periods during startup without full lubrication may result in reduced compressor life.

[0006] While not generally known in the compressor field, it is known to provide pre-oiler systems in connection with internal combustion engines. However, U.S. Pat. No. 6,550,258 to Shoulders discloses pre-start bearing lubrication for a refrigeration system compressor. Many types of engine pre-oilers have been previously provided in an attempt to pre-oil certain moving parts of an engine prior to the engine being adequately oiled or lubricated by the engine lubrication system. One such system is disclosed in U.S. Pat. Nos. 5,348,121 and 5,244,059 to McLaughlin. This patent discloses the use of a normally closed, solenoid operated valve interposed in an oil line and which permits oil passage through the line to the engine when activated to the open position. Another example of pre-lubrication adapted to lubricate an engine at start-up is disclosed by U.S. Pat. No. 5,694,896 to Melvin. This patent discloses a simple pre-oiler that has a hollow pressure vessel and a control valve tapped into the engine oil system. The control valve has a plug which is balanced by the engine oil pressure and the vessel pressure. Finally, U.S. Pat. No. 3,556,070 to Holcomb discloses a solenoid valve pre-oiler lubricating device as another example of a pre-oiler system used in connection with an internal combustion engine.

[0007] Another method of providing pre-lubrication in the field of internal combustion engines is to utilize a pre-start oil pump which augments the main lubrication pump for the engine. One such example is disclosed in U.S. Pat. No. 5,511,522 to Tran. U.S. Pat. No. 6,349,692 to Reinosa disclose the use of an electric pre-oiler pump for an internal combustion engine that is controlled by an external controller and is located within the engine. U.S. Pat. No. 4,893,598 to Stasuik discloses a manually-activated positive displacement pump as a pre-oiler device in an internal combustion engine. U.S. Pat. No. 4,834,039 to Apostolides discloses a multistage pre-lubricant pump. U.S. Pat. No. 4,703,727 to Cannon discloses a pre-start engine lubrication system for an internal combustion engine in which an external source of pressurized oil is connected through an engine oil filter port to lubricate the engine passageways before the engine starting mechanism is engaged. Additional pre-lubrication devices for internal combustion engines are disclosed in U.S. Pat. Nos. 5,236,064 to Wagoner; 5,156,120 to Kent; 3,583,525 to Holcomb; and 2,838,039 to Smith et al. Finally, U.S. Pat. No. 3,637,048 to Mount discloses an auxiliary oil pump for a centrifugal compressor which operates in the event of power failure to a main oil pump for the centrifugal compressor.

[0008] In view of the foregoing, a need exists for a pre-start lubrication system that is desirably adapted of use with an air compressor.

SUMMARY OF THE INVENTION

[0009] Generally, a pre-lubrication system is described herein and is provided to augment the normal lubrication system of an air compressor. The pre-lubrication system is generally intended to be operated just prior to operation of the air compressor to ensure that pressurized oil is available during start-up of the air compressor. In one embodiment, air compressor pre-lubrication system comprises an oil pump, a priming tank, and a control valve. The oil pump is connected to an oil sump and comprises a discharge line connected to an air compressor. The priming tank is connected to the oil pump to receive pressurized oil. The control valve is provided in an outline line connected to the priming tank and is further connected to the oil pump discharge line. The priming tank is configured to maintain a charge of oil from the oil pump and selectively release the charge of oil through actuation of the control valve.

[0010] The control valve may comprise a solenoid valve. The priming tank may comprise a volume at least equal to the volumetric sum of lubrication passageways in the air compressor. The priming tank may comprise a diaphragm adapted to force oil into the discharge line upon actuation of the control valve. An inlet check valve may be disposed upstream of the priming tank. An outlet check valve may be disposed upstream of the control valve. The priming tank may be fluidly connected to the oil sump via sump return line and an oil pump relief valve.

[0011] In another embodiment, the air compressor pre-lubrication system comprises an oil pump and an auxiliary pre-lubrication oil pump. The oil pump is connected to an oil sump and comprises a discharge line connected to an air compressor. The pre-lubrication oil pump is connected to the oil sump and is further fluidly coupled to the discharge line leading to the air compressor. The pre-lubrication pump may be adapted to provide pressurized oil to the discharge line prior to operation of the air compressor. The pre-lubrication pump may comprise an electric pump.

[0012] Another aspect described herein relates to a method of pre-lubricating an air compressor comprising the steps of storing a charge of oil in a priming tank during normal operation of the air compressor, maintaining the charge of oil in the priming tank during stoppage of the air compressor, and selectively releasing the charge of oil before air compressor start-up to provide pressurized lubrication to the air compressor.

[0013] The step of releasing the charge of oil may comprise actuation of a control valve. The control valve may comprise a solenoid valve. The priming tank may comprise a volume at least equal to the volumetric sum of lubrication passageways in the air compressor. The priming tank may comprise a diaphragm and the method may further comprise the diaphragm forcing oil into the discharge line upon actuation of a control valve. The step storing a charge of oil in the priming

tank may be accomplished by an oil pump fluidly coupled to the priming tank. The method may further comprise preventing return flow to the oil pump with an inlet check valve provided upstream of the priming tank. The step of releasing the charge of oil may comprise actuation of a control valve and an outlet check valve is provided upstream of the control valve.

[0014] Further details and advantages will be made clear upon consideration of the following description with reference to the accompanying drawings, all of which form a part of this specification, and wherein like reference numerals designate like part throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic view of an air compressor pre-lubrication system according to one embodiment.

[0016] FIG. **2** is a schematic view of an air compressor pre-lubrication system according to another embodiment.

[0017] FIG. **3** is a schematic view of an air compressor pre-lubrication system according to a further embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] For purposes of the description hereinafter, spatial orientation terms, as used, shall relate to the referenced embodiment as it is oriented in the accompanying drawing figures or otherwise described in the following detailed description. However, it is to be understood that the embodiments described hereinafter may assume many alternative variations and configurations. It is also to be understood that the specific devices, features, and components illustrated in the accompanying drawing figures and described herein are simply exemplary and should not be considered as limiting.

[0019] Referring to FIG. **1**, an air compressor pre-lubrication system **20** is schematically shown. Pre-lubrication system **20** is provided to augment the normal lubrication system of an air compressor **45** and is intended to be operated just prior to operation of the air compressor **45** to ensure that pressurized oil is available during start-up of the air compressor **45**. Without pre-lubrication system **20**, during air compressor start-up, there would be a time when the air compressor **45** lacks full pressure lubrication. For applications where air compressor **45** must be started repeatedly, the accumulated result of these periods without full pressure lubrication will likely result in reduced life.

[0020] In general, pre-lubrication system **20**, according to one exemplary embodiment, works by charging a priming tank (described herein) with pressurized oil during normal operation of air compressor **45**. When air compressor **45** is shut down, this priming tank maintains lubrication oil at normal system operating pressure for the air compressor **45**. When it is desired to start air compressor **45**, just prior to such start-up, the priming tank is "released" to be in fluid communication with the lubrication passages (not shown) of air compressor **45**. In this manner, full pressure lubrication is available at the moment of air compressor start-up.

[0021] Pre-lubrication system **20** is adapted to work in conjunction with an air compressor oil lubrication pump **40**, as shown in FIG. **1**. Oil pump **40** comprises an oil pump cavity **42** in fluid communication via an oil pump inlet valve **23** and inlet line **25** to an oil sump **27**. Oil pump cavity **42** of oil pump **40** is further in fluid communication with oil sump **27** via an outlet relief valve **30** and a sump return line **32**. Oil pump **40** provides lubrication oil to the lubrication passageways (not shown) of an air compressor **45** via an oil pump discharge valve **34** and discharge line **36**.

[0022] Oil pump **40** is adapted to provide lubrication oil under pressure to pre-lubrication system **20** in accordance with the present embodiment. In the present embodiment, a branch line **50** is connected to the oil pump cavity **42** and includes a first or inlet check valve **52**. Branch line **50** connects to a priming tank **55** to provide pressurized lubrication oil to the priming tank **55**. Priming tank **55** is fluidly connected to discharge line **36** via an outlet line **56** comprising a control valve **57**, desirably a solenoid valve, and a second check valve **60**. As is apparent from FIG. **1**, priming tank **55** is positioned between first check valve **52** and control valve **57** such that the first check valve **52** allows oil flow from oil pump cavity **42** to the priming tank **55** but prevents return flow from the priming tank **55** to the oil pump cavity **42**. Second check valve **60** is positioned downstream from control valve **57** and prevents return flow of oil from the second check valve **60** towards the control valve **57**. A choke **65** and oil pressure indicator **67** are also connected to discharge line **36** to monitor the system oil pressure for the air compressor **45**.

[0023] Priming tank **55** is desirably a small reservoir with a diaphragm such as an expansion tank. Priming tank **55** is slightly larger in volume than the volumetric sum of the air compressor's lubrication passageways. During operation of oil pump **40**, priming tank **55** is charged with oil pressure generally equal to the operating pressure of air compressor **45** via branch line **50** which is connected to the oil pump cavity **42**. As is typical, when the air compressor **45** is shut down the oil pressure within the air compressor **45** quickly bleeds back to the oil sump **27**. In prior art arrangements, with the lubrication passageways emptied of oil, when the air compressor is restarted it will run without lubrication or with partial lubrication for a period of time until the passages are once again filled and pressurized lubrication oil. However, with pre-lubrication system **20** in place as shown in FIG. **1**, priming tank **55** maintains a ready charge of oil pressure after shutdown. This pressurized oil is introduced back into the lubrication passageways in air compressor **45** via energizing control valve **57** (e.g., a solenoid valve) just prior to restarting air compressor **45**. The diaphragm in priming tank **55** acts to force oil into the lubrication passageways in air compressor **45** maintaining oil pressure until the air compressor **45** starts. When air compressor **45** is started, it is already at approximately normal operating pressure avoiding the period of partial lubrication. Priming tank **55** is then recharged by oil pump **40** so that the process may repeat.

[0024] Referring to FIG. **2**, another embodiment of the air compressor pre-lubrication system **20** is shown. In FIG. **2**, like parts are identified with like reference numerals as found in FIG. **1**. Pre-lubrication system **20** of FIG. **2** is generally similar to that shown in FIG. **1** except that priming tank **55** is located in-line before outlet relief valve **30** and sump return line **32**. Accordingly, pre-lubrication system **20** of FIG. **2** is generally adapted to work in conjunction with air compressor oil lubrication pump **40** in generally the same manner as shown in FIG. **1**. Referring now to FIG. **2**, oil pump **40** comprises an oil pump cavity **42** in fluid communication via oil pump inlet valve **23** and inlet line **25** to oil sump **27**. As indicated, priming tank **55** is located in-line and upstream of outlet relief valve **30** and sump return line **32** leading to oil sump **27**. Oil pump **40** provides lubrication oil to the lubrica-

tion passageways (not shown) of air compressor **45** via oil pump discharge valve **34** and discharge line **36** in like manner to that shown in FIG. **1**.

[0025] Oil pump **40** is adapted to provide lubrication oil under pressure to pre-lubrication system **20** in accordance with the present embodiment. In the present embodiment, branch line **50** is connected to the oil pump cavity **42** and includes a first or inlet check valve **52**. Branch line **50** connects to priming tank **55** to provide pressurized lubrication oil to the priming tank **55**. Priming tank **55** is fluidly connected to discharge line **36** via outlet line **56** comprising control valve **57**, desirably a solenoid valve, and a second check valve **60**. As is apparent from FIG. **2**, priming tank **55** is again positioned between first check valve **52** and control valve **57** such that the first check valve **52** allows oil flow from oil pump cavity **42** to the priming tank **55** but prevents return flow from the priming tank **55** to the oil pump cavity **42**. Second check valve **60** is positioned downstream from control valve **57** and prevents return flow of oil from the second check valve **60** towards the control valve **57**. A choke **65** and oil pressure indicator **67** is also connected to discharge line **36** to monitor the system oil pressure for the air compressor **45**.

[0026] Priming tank **55** is desirably a small reservoir with a diaphragm such as an expansion tank. Priming tank **55** is slightly larger in volume than the volumetric sum of the air compressor's lubrication passageways. During operation of oil pump **40**, priming tank **55** is charged with oil pressure generally equal to the operating pressure of air compressor **45** via branch line **50** which is connected to the oil pump cavity **42**. As is typical, when the air compressor **45** is shut down, the oil pressure within the air compressor **45** quickly bleeds back to the oil sump **27**. In prior art arrangements, with the lubrication passageways emptied of oil, when the air compressor is restarted it will run without lubrication or with partial lubrication for a period of time until the passages are once again filled and pressurized with lubrication oil. However, with pre-lubrication system **20** in place as shown in FIG. **2**, priming tank **55** maintains a ready charge of oil pressure after shutdown. This pressurized oil is introduced back into the lubrication passageways in air compressor **45** via energizing control valve **57** (e.g., a solenoid valve) just prior to restarting air compressor **45**. The diaphragm in priming tank **55** acts to force oil into the lubrication passageways in air compressor **45** maintaining oil pressure until the air compressor **45** starts. When air compressor **45** is started, it is already at approximately normal operating pressure avoiding the period of partial lubrication. Priming tank **55** is then recharged by oil pump **40** so that the process may repeat.

[0027] Referring to FIG. **3**, another embodiment of pre-lubrication system **20** is shown and wherein like parts are again identified with like reference numerals to those used in FIG. **1**. In FIG. **3**, oil pump **40** again comprises an oil pump cavity **42** in fluid communication via an oil pump inlet valve **23** and inlet line **25** to an oil sump **27**. Oil pump cavity **42** of oil pump **40** is further in fluid communication with oil sump **27** via an outlet relief valve **30** and a sump return line **32**. Oil pump **40** provides lubrication oil to the lubrication passageways (not shown) of an air compressor **45** via an oil pump discharge valve **34** and discharge line **36**.

[0028] In FIG. **3**, pre-lubrication system **20** comprises an auxiliary oil pump **70** connected to oil sump **27** via an inlet feed line **72**. A discharge line **74** from auxiliary oil pump **70** is connected to discharge line **36** leading to air compressor **45** and includes an auxiliary or second check valve **60** in like manner to previous embodiments. A choke **65** and oil pressure indicator **67** is also connected to discharge line **36** to monitor the system oil pressure for the air compressor **45**. The auxiliary oil pump **70** may be an electric pump located in the oil sump **27** of a crankcase associated with air compressor **45**. The auxiliary oil pump **70** is capable of providing oil to the air compressor **45** at pressure and flow rate generally equal to that of the main air compressor pump. During operation of the air compressor pre-lubrication system **20**, when air compressor **45** is shut down, the oil pressure within the air compressor **45** quickly bleeds back to oil sump **27**. Prior to re-starting the air compressor **45**, the auxiliary oil pump **70** is powered before the air compressor drive motor is started and provides lubrication to the air compressor **45** substantially at normal operating pressure thereby avoiding a period of partial lubrication. Once the air compressor drive motor has started and the main air compressor pump is operating at full capacity, the auxiliary oil pump **70** may be shutdown. Accordingly, by providing an auxiliary oil pump **70** to provide substantially normal oil pressure to air compressor **45** prior to start-up of the air compressor **45**, periods of partial or no lubrication are desirably eliminated and the operating life of the air compressor **45** is extended.

[0029] While the foregoing discussion describes several embodiments of pre-lubrication system **20**, each of these embodiments may be provided as an external addition to the physical structure of air compressor **45** (e.g., an add-on type design) or, alternatively, as an internal adjunct to the air compressor **45**. Accordingly, the various embodiments of pre-lubrication system **20** described hereinabove may be provided external to or internal to the air compressor **45**. In the internal configuration, it may be desirable for control valve **57** to be external from the physical structure of air compressor **45**.

[0030] While embodiments of an air compressor pre-lubrication system were provided in the foregoing description, those skilled in the art may make modifications and alterations to these embodiments without departing from the scope and spirit of the invention. Accordingly, the foregoing description is intended to be illustrative rather than restrictive. The invention described hereinabove is defined by the appended claims and all changes to the invention that fall within the meaning and the range of equivalency of the claims are to be embraced within their scope.

1. An air compressor pre-lubrication system, comprising:

an oil pump connected to an oil sump and comprising a discharge line connected to an air compressor;

a priming tank connected to the oil pump to receive pressurized oil;

a control valve provided in an outline line connected to the priming tank and further connected to the oil pump discharge line; and

wherein the priming tank is configured to maintain a charge of oil from the oil pump and selectively release the charge of oil through actuation of the control valve.

2. An air compressor pre-lubrication system as claimed in claim **1**, wherein the control valve comprises a solenoid valve.

3. An air compressor pre-lubrication system as claimed in claim **1**, wherein the priming tank comprises a volume at least equal to the volumetric sum of lubrication passageways in the air compressor.

4. An air compressor pre-lubrication system as claimed in claim **1**, wherein the priming tank comprises a diaphragm adapted to force oil into the discharge line upon actuation of the control valve.

5. An air compressor pre-lubrication system as claimed in claim **1**, further comprising an inlet check valve upstream of the of the priming tank.

6. An air compressor pre-lubrication system as claimed in claim **7**, further comprising an outlet check valve upstream of the control valve.

7. An air compressor pre-lubrication system as claimed in claim **1**, wherein the priming tank is fluidly connected to the oil sump via sump return line and an oil pump relief valve.

8. An air compressor pre-lubrication system, comprising:

an oil pump connected to an oil sump and comprising a discharge line connected to an air compressor;

a pre-lubrication oil pump connected to the oil sump and fluidly coupled to the discharge line leading to the air compressor; and

wherein the pre-lubrication pump is adapted to provide pressurized oil to the discharge line prior to operation of the air compressor.

9. An air compressor pre-lubrication system as claimed in claim **8**, wherein the pre-lubrication pump comprises an electric pump.

10. A method of pre-lubricating an air compressor comprising the steps of:

storing a charge of oil in a priming tank during normal operation of the air compressor;

maintaining the charge of oil in the priming tank during stoppage of the air compressor; and

selectively releasing the charge of oil before air compressor start-up to provide pressurized lubrication to the air compressor.

11. A method as claimed in claim **10**, wherein the step of releasing the charge of oil comprises actuation of a control valve.

12. A method as claimed in claim **11**, wherein the control valve comprises a solenoid valve.

13. A method as claimed in claim **10**, wherein the priming tank comprises a volume at least equal to the volumetric sum of lubrication passageways in the air compressor.

14. A method as claimed in claim **10**, wherein the priming tank comprises a diaphragm and the method comprises the diaphragm forcing oil into the discharge line upon actuation of a control valve.

15. A method as claimed in claim **10**, wherein the step storing a charge of oil in the priming tank is accomplished by an oil pump fluidly coupled to the priming tank.

16. A method as claimed in claim **15**, further comprising preventing return flow to the oil pump with an inlet check valve provided upstream of the of the priming tank.

17. A method as claimed in claim **10**, wherein the step of releasing the charge of oil comprises actuation of a control valve and an outlet check valve is provided upstream of the control valve.

* * * * *