(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 March 2008 (13.03.2008)

PCT

(10) International Publication Number
WO 2008/030760 A2

(51) International Patent Classification:
F04D 17/02 (2006.01)

(21) International Application Number:
PCT/US2007/077274

(22) International Filing Date: 30 August 2007 (30.08.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/824,516 5 September 2006 (05.09.2006) US

(71) Applicant *(for all designated States except US)*: **NEW YORK AIR BRAKE CORPORATION** [US/US]; 748 Starbuck Avenue, Watertown, NY 13601 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **HARTL, Michael** [DE/DE]; Buergermeister Press Strasse 2a, 82008 Unterhaching (DE). **MCCURDY, William, B.** [US/US]; 20 Prospect Street, Adams, NY 13605 (US).

(74) Agent: **PALAN, Perry**; Barnes & Thornburg LLP, 750 17th Street, NW, Suite 900, Washington, DC 20006 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

WO 2008/030760 A2

(54) Title: OIL-FREE AIR COMPRESSOR SYSTEM WITH INLET THROTTLE

(57) Abstract: The present air compressor system includes at least one piston stage connected to the air inlet of the compressor by an inlet valve and connected to the compressed air outlet of the compressor by an outlet valve; a motor driving the piston stage; and an adjustable throttle connected between the air inlet and the inlet valve. A controller controls the motor and the throttle to substantially close the throttle to unload the piston stage when necessary.

OIL-FREE AIR COMPRESSOR SYSTEM WITH INLET THROTTLE

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] The present disclosure relates generally to air compressors and more specifically to an oil-free air compressor having an inlet throttle.

[0002] An air compressor, for example, two-stage air compressors include a first low pressure compression stage connected through an inter-cooling stage to a high pressure compression stage whose output is provided through an after cooling stage to an air reservoir. Examples are shown by U.S. Patents 6,776,587 and 6,973,868.

[0003] It is well-known in the multistage air compressors to have unloading valves at the output of the inter-cooling stage as illustrated by U.S. Patent 6,287,085 and at the output of the after cooling stage as illustrated in U.S. Patent 4,819,123. The unloading valve connects the pressurized air in the system to atmosphere or vents the pressure to unload the compression stage. Unloading is required for starting torque which exceeds 100 ft-lbs for example. Depending on the type of drive, for example, pneumatic, hydraulic, electric or chain, the torque at which the unlading takes place will vary. The unloading reduces the load on the drive and reduces power consumption.

[0004] Screw compressors have been unloaded by providing a throttle or butterfly valve at the air inlet to the compressor. The butterfly valve is normally open during operation of the compressor. To unload the compressor, the butterfly valve is closed. Thus no air is being provided to be compressed and therefore the compressor is unloaded. Screw compressor also includes an air oil filter at its output to remove the lubricating oil inherent in the system.

[0005] Piston air compressors which include lubrication of the pistons have not used an adjustable throttle valve at the input. This is because the vacuum created in the compression cylinder when the throttle valve is closed will suck or draw the oil past the piston sealing rings. This area around the sealing rings is the only inlet to the compression cylinder during the intake or sucking cycle. This action creates undesirable and excessive oil consumption.

[0006] An oil-free air compressor according to the present disclosure includes an air inlet and a compressed air outlet; and at least one piston stage connected to the air inlet by an inlet valve and the compressed air outlet by an outlet valve. A motor drives the piston stage; and an adjustable throttle is connected between the air inlet and the inlet valve. A controller controls the motor and the throttle to close the throttle to unload the piston stage when necessary.

[0007] The compressor includes crankcase to which piston stage and the air inlet are mounted; and the throttle is mounted in a conduit connecting the crankcase to inlet valve. The throttle

may be a butterfly valve. The compressor may have two piston stages; and the throttle is between the air inlet and the inlet valve of the first piston stage. The controller substantially closes the throttle to unload the piston stage for a pre-selected state of the compressor.

[0008] A method of operating the oil-free air compressor includes determining the state of the compressor; and substantially closing the throttle to unload the piston stage for a pre-selected state of the compressor. The pre-selected state is the restart of the motor after a brief delay.

[0009] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[00010] Figure 1 is a perspective view of a compressor system according to the prior.

[00011] Figure 2 is a schematic of an oil-free compressor system according to the present disclosure.

[00012] Figure 3 is perspective view of an inlet throttle according to the present disclosure.

[00013] Figure 4 is another perspective view of an inlet throttle according to the present disclosure

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[00014] An oil-free or dry-running piston compressor is illustrated in the Figures 1 and 3 as a two-stage compressor unit 10. A drive unit 12 is mounted to a crankshaft 13A (shown in Figure 2) in crankcase 13 and may be, for example, an electric motor. The crankshaft 13 includes at least one piston cylinder 14 per stage. The first stage of compression includes piston cylinders 14b and 14c, for example receiving air from air inlet 11 through filter 15 and conduit 21. The second high-pressure stage is performed by piston cylinder 14a. The compressor unit 10 includes a cooling system 16 having an output 17 of the compressed air. A compressed air outlet 17 is generally connected via a check valve 19 to a reservoir (not shown).

[00015] A cooling system 16 for the two-stage compressor includes an inter-cooling stage 20 and an after cooling stage 22. The inter-cooling stage 20 has an inlet connected by pipe 24 from the outlet of first stage piston cylinder 14b to the inter-cooling stage 20. The outlet of inter-cooling stage 20 is connected via pipe 26 to the inlet of the second stage piston cylinder 14a. The output of the second stage piston cylinder 14a is connected via pipe 28 to an inlet of the after cooling stage 22.

[00016] The piston cylinders 14a, 14b and 14c each include an inlet valve 30 and outlet valve 32 connected to compression chamber 34. For illustrative purposes the valves 30 and 32 are shown as simple check valves in Figure 2. The valves 30 and 32 may be pneumatically or electrically controlled by controller 52 or may be pneumatically controlled by pilot signals from various pipe and passages in the compressor system. The first stage 14b, c is shown at the end of its input or suction cycle and second stage 14a is shown at the end of its compression cycle.

[00017] There is a feedback passage 36 between the chambers 34 and the connection to the air inlet valve 30 of pistons stages 14a and 14b, c.

[00018] An adjustable throttle 40 is connected between the air inlet 11 and the inlet valve 30 of the first stage 14b, c. As shown in Figure 2, the throttle 40 is in conduit 21 between the filter and the inlet valve 30 or specifically between the crankcase 13 and the inlet valve 30 in Figures 3 and 4. The throttle 40 may be a butterfly valve as shown in Figures 2 and 4. The throttle 14 is pivotally mounted in the modified conduit 21' as is actuator 42. A control port 44 is connected to, not shown, the controller 52. The actuator may be pneumatic or electric. The conduit 21' is mounted to the crankcase 13 at flange 21A and to the first piston stage 14 b, c at flange 21B. Both of the pistons would include the throttle at its input.

[00019] The throttle 40 is controlled by the controller 52 which also controls the motor 12. The controller 52 controls the on/off cycling of the motor 12 based on sensed conditions through sensor input 54. There may be one or more inputs connected to the controller 52 to different sensors throughout the system. As well-known in prior art, these may be pressure sensors to different ports of the system, it may be temperature sensors or other sensors used in the control of compressors.

[00020] When the controller 40 is cycling the motor 12, the pressure build-up in the system acts as a load on the compressor and back onto motor 12. If the system is charged, the restarting of the motor is against the pressure in the piston's cylinders 34, as well as the various pipes and passages. It is well-known in the prior art, the pressurized system is unloaded to allow easy restarting of the motor 12. This is generally after a brief period of shut-down when the system has maintained the pressure. In the present compressor system when unloading is required, the controller 52 substantially closes the normally open throttle 40 to prevent the introduction of air from inlet 11 into chamber 34. The downward motion or the sucking or inlet cycle of 14b will not introduce any air into chamber 34. Thus there will be no additional air compressed by the compression cycle of 14b in chamber 34. This effectively unloads the first stage.

[00021] Although the maximum unloading occurs when the throttle 40 is totally closed, a small crack or leak allowing some input from air inlet 11 prevents overheating in the piston chamber 34. This does not adversely affect the efficiency of the unloading.

[00022] Since the compressor 10 is an oil-free compressor, there is no oil to be sucked into chamber 34 when the throttle 40 is substantially closed and a partial vacuum is created. Thus the compressor passages stay clean and there is no air/oil separator needed at the output 17 of the system.

[00023] Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation. The present adjustable throttle may be used on an oil-free piston compressor with a single compression stage. The scope of the present invention is to be limited only by the terms of the appended claims.

What is claimed:

1. An oil-free air compressor comprising:

an air inlet and a compressed air outlet;

at least one piston stage connected to the air inlet by an inlet valve and the compressed air outlet by an outlet valve;

a motor driving the piston stage;

an adjustable throttle connected between the air inlet and the inlet valve; and

a controller controlling the motor and the throttle; the controller substantially closing the throttle to unload the piston stage.

2. The compressor according to claim 1, wherein the throttle is a butterfly valve.

3. The compressor according to claim 1, wherein the compressor has two piston stages; and the throttle is between the air inlet and the inlet valve of the first piston stage.

4. The compressor according to claim 1, wherein the controller substantially closes the throttle to unload the piston stage for a pre-selected state of the compressor.

5. The compressor according to claim 4, wherein the pre-selected state is the restart of the motor after a brief delay.

6. The compressor according to claim 1, wherein the compressor includes a crankcase to which piston stage and the air inlet are mounted; and the throttle is mounted in a conduit connecting the crankcase to inlet valve.

7. The compressor according to claim 1, wherein the piston stage includes two parallel connected pistons and each piston has an adjustable throttle connected to the inlet valve.

8. An oil-free air compressor comprising:

an air inlet connected to a crankcase and a compressed air outlet;

at least one piston stage mounted to on the crankcase, having an inlet valve connected to the crankshaft by conduit and having an outlet valve connected to the compressed air outlet; and

an adjustable throttle in the conduit between the crankcase and the inlet valve.

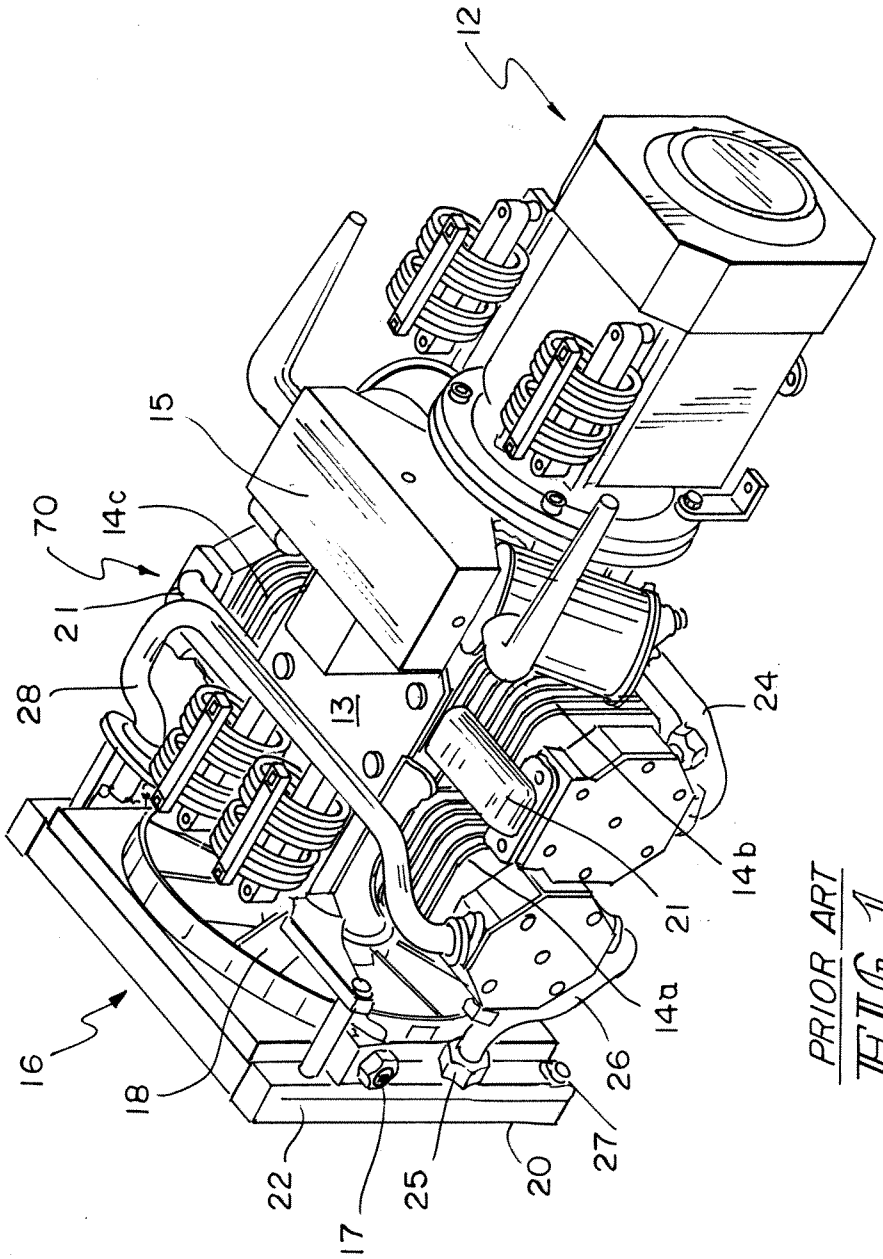
9. The compressor according to claim 8, wherein the piston stage includes two parallel connected pistons, and each piston has an adjustable throttle mounted in the conduit connecting the inlet valve and the crankcase.

10. A method of operating an oil-free air compressor which includes an adjustable throttle between an air inlet of the compressor and the inlet of a piston stage driven by a motor, the method comprising:

determining the state of the compressor; and

substantially closing the throttle to unload the piston stage for a pre-selected state of the compressor.

11. The compressor according to claim 10, wherein the pre-selected state is the restart of the motor after a brief delay.



PRIOR ART
FIG. 1

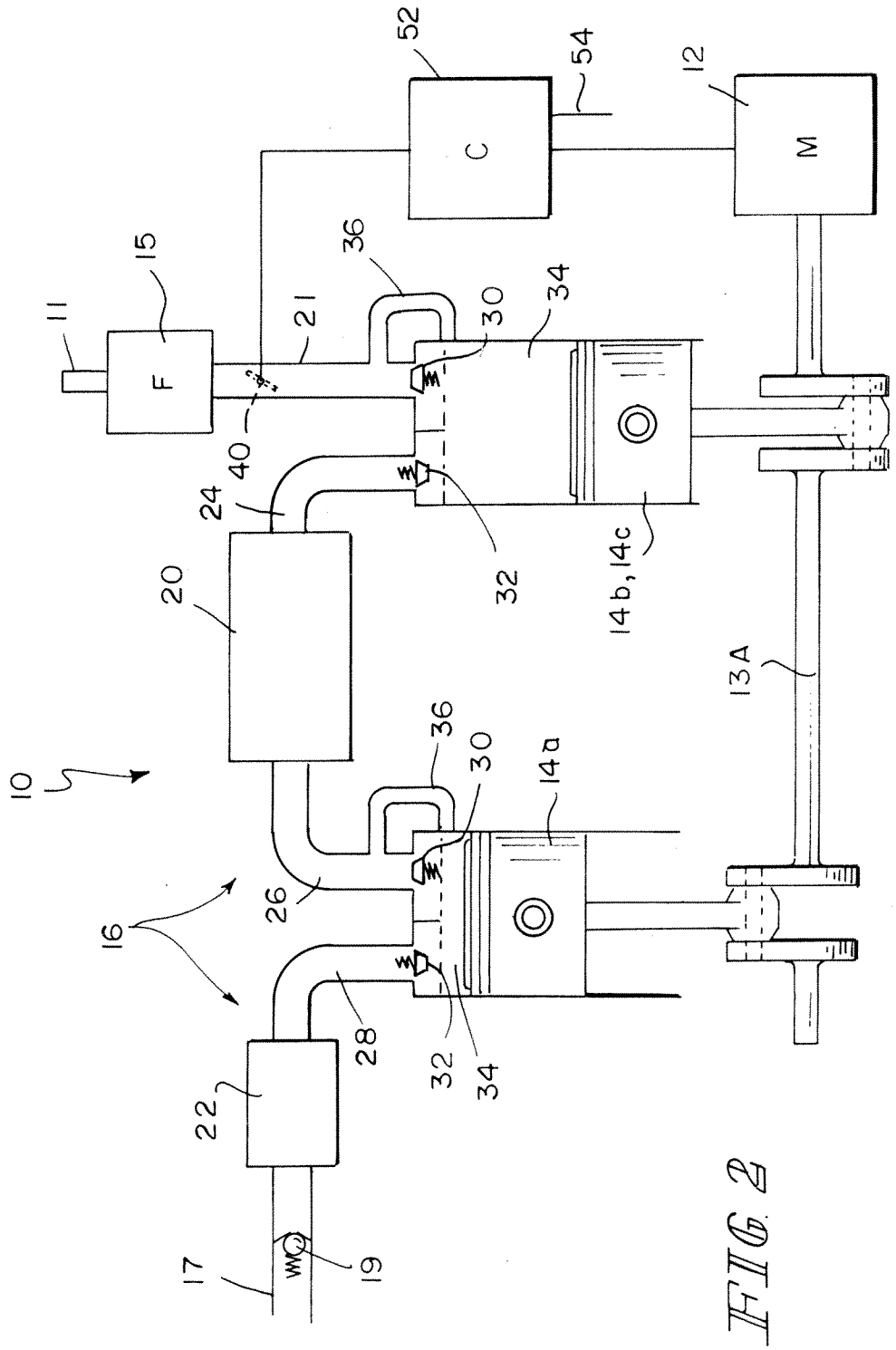

52
54
12
C
M
15
36
34
11
21
30
F
40
24
32
14b, 14c
20
13A
10
36
30
14a
16
26
28
32
34
22
17
19

FIG 2

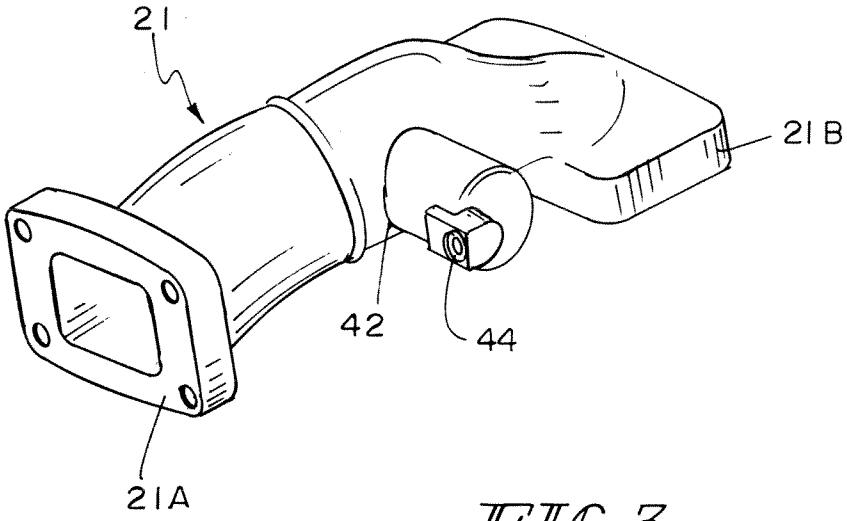


FIG. 3

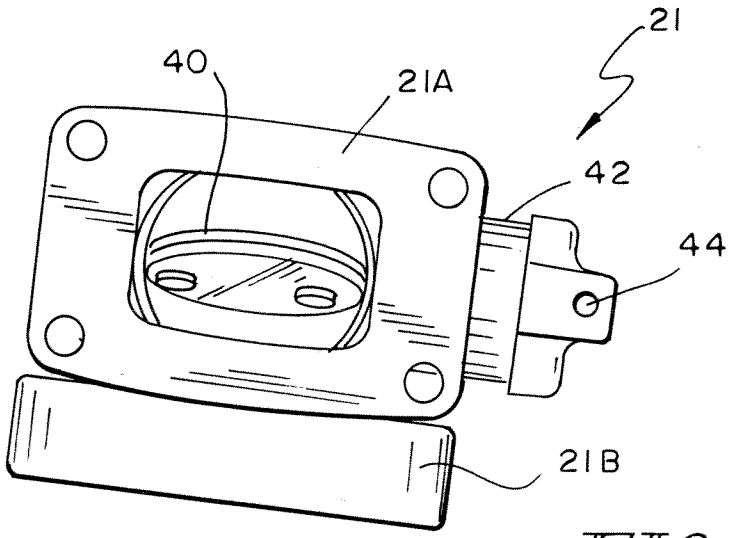


FIG. 4