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(54) OIL-FREE RECIPROCATING PISTON AIR COMPRESSOR SYSTEM WITH INLET THROTTLE

ÖLFREIES LUFT-HUBKOLBENKOMPRESSORSYSTEM MIT EINLASSDROSSEL

SYSTÈME DE COMPRESSEUR D'AIR À PISTON RÉCIPROCANT SANS HUILE AVEC ÉTRANGLEMENT D'ADMISSION

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EP 2 059 679 B1

Description

[0001] The present disclosure relates generally to air compressors and more specifically to an oil-free reciprocating piston 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, as disclosed in US 4,549,856 A, 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] U.S. Patent 2,661,893 discloses a compressor with a throttle being used as a speed regulator acting in response to variations in the discharge pressure to change the speed of the motor.

[0007] U.S. Patent 5,540,558 discloses a compressor with a compressor stage and a throttle at the air inlet to the compressor.

[0008] U.S. Patent 5,701,873 discloses a compressor with a compressor stage and an adjustable throttle which serves to adjust a flow through quantity of Diesel oil.

[0009] U.S. Patent 6,505,613 discloses an air compressor with a compressor stage and a throttle being controlled by a electrical control unit, where the control unit energizes an actuator to partially close the throttle to restrict air flow through the inlet as the amount of air used by injectors varies with engine speed.

[0010] An oil-free reciprocating piston air compressor system with an inlet throttle is known from BOGE Kompressoren.

[0011] An oil-free reciprocating piston 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 for a restart of the motor after a brief delay.

[0012] 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.

[0013] 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

[0014]

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

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

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

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

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] 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).

[0016] 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.

[0017] The piston cylinders 14a, 14h 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. Then 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.

[0018] 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.

[0019] 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 14b, c at flange21B. Both of the pistons would include the throttle at its input.

[0020] The throttle 40 is controlled by the controller 52 which also controls the motor 12. The controller 52 controls the on/of 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.

[0021] 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 chamber34. Thus there will be no additional air compressed by the compression cycle of 14b in chamber 34. This effectively unloads the first stage.

[0022] 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. 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.

Claims

1. An oil-free reciprocating piston air compressor (10) comprising:

   an air inlet (11) and a compressed air outlet (17);
   at least one piston stage (14a, b, c) connected to the air inlet (11) by an inlet valve (30) and the compressed air outlet (17) by an outlet valve (32);
   a motor (12) driving the piston stage (14a, b, c);
   an adjustable throttle (40) connected between the air inlet (11) and the inlet valve (30),
   characterized in that
   the compressor (10) further comprises a controller (52) controlling the motor and the throttle, the controller controlling on/off cycling of the motor (12) based on sensed conditions through sensor input ; whereby the controller (52) is configured to substantially close the throttle (40) to unload the piston stage (14a, b, c) for a restart of the motor (12).

2. The compressor according to claim 1, wherein the throttle (40) is a butterfly valve.

3. The compressor according to claim 1, wherein the compressor (10) has two piston stages (14a, b, c); and the throttle (40) is between the air inlet (11) and the inlet valve (30) of the first piston stage (14b, c).

4. The compressor according to claim 1, wherein the compressor (10) includes a crankcase (13) to which piston stage (14a, b, c) and the air inlet (11) are mounted; and the throttle (40) is mounted in a conduit (21) connecting the crankcase (13) to inlet valve (30).

5. The compressor according to claim 1, wherein the piston stage (14a, b, c) includes two parallel con-

nected pistons and each piston has an adjustable throttle (40) connected to the inlet valve (30).

6. The oil-free air compressor according to any one of the preceding claims, wherein the air inlet (11) is connected to a crankcase (13) and wherein the at least one piston stage (14a, b, c) is mounted to on the crankcase (13), the inlet valve (30) is connected to the air inlet (11) by conduit (21); and wherein the adjustable throttle (40) is in the conduit (21) between the crankcase (13) and the inlet valve (30).

7. The compressor according to claim 6, wherein the piston stage (14a, b, c) includes two parallel connected pistons, and each piston has an adjustable throttle (40) mounted in the conduit (21) connecting the inlet valve (30) and the crankcase (13).

8. The compressor according to any one of the preceding claims, wherein when the throttle (40) is substantially closed a small crack or leak remains allowing some input from air inlet (11).

Patentansprüche

1. Ölfreier Hubkolben-Luftkompressor (10), umfassend:

einen Lufteinlass (11) und einen Druckluftauslass (17);
mindestens eine Kolbenstufe (14a, b, c), die über ein Einlassventil (30) mit dem Lufteinlass (11) und über ein Auslassventil (32) mit dem Druckluftauslass (17) verbunden ist;
einen Motor (12), der die Kolbenstufe (14a, b, c) antreibt;
eine einstellbare Drosselklappe (40), die zwischen dem Lufteinlass (11) und dem Einlassventil (30) angeschlossen ist,
dadurch gekennzeichnet, dass
der Kompressor (10) ferner einen Controller (52) umfasst, der den Motor und die Drosselklappe steuert, wobei der Controller das Ein-/Ausschalten des Motors (12) auf der Grundlage von erfassten Bedingungen durch einen Sensoreingang steuert; wobei der Controller (52) so konfiguriert ist, dass er die Drosselklappe (40) im Wesentlichen schließt, um die Kolbenstufe (14a, b, c) für einen Neustart des Motors (12) zu entlasten.

2. Kompressor nach Anspruch 1, bei dem die Drosselklappe (40) ein Schmetterlingsventil ist.

3. Kompressor nach Anspruch 1, wobei der Kompressor (10) zwei Kolbenstufen (14a, b, c) aufweist und die Drosselklappe (40) sich zwischen dem Lufteinlass (11) und dem Einlassventil (30) der ersten Kolbenstufe (14b, c) befindet.

4. Kompressor nach Anspruch 1, wobei der Kompressor (10) ein Kurbelgehäuse (13) aufweist, an dem die Kolbenstufe (14a, b, c) und der Lufteinlass (11) montiert sind, und die Drosselklappe (40) in einer Leitung (21) montiert ist, die das Kurbelgehäuse (13) mit dem Einlassventil (30) verbindet.

5. Kompressor nach Anspruch 1, wobei die Kolbenstufe (14a, b, c) zwei parallel geschaltete Kolben umfasst und jeder Kolben eine einstellbare Drosselklappe (40) aufweist, die mit dem Einlassventil (30) verbunden ist.

6. Ölfreier Luftkompressor nach einem der vorhergehenden Ansprüche, wobei der Lufteinlass (11) mit einem Kurbelgehäuse (13) verbunden ist und wobei die mindestens eine Kolbenstufe (14a, b, c) an dem Kurbelgehäuse (13) montiert ist, das Einlassventil (30) durch eine Leitung (21) mit dem Lufteinlass (11) verbunden ist, und wobei die einstellbare Drosselklappe (40) in der Leitung (21) zwischen dem Kurbelgehäuse (13) und dem Einlassventil (30) ist.

7. Kompressor nach Anspruch 6, bei dem die Kolbenstufe (14a, b, c) zwei parallel geschaltete Kolben enthält und jeder Kolben eine einstellbare Drosselklappe (40) aufweist, die in der das Einlassventil (30) und das Kurbelgehäuse (13) verbindenden Leitung (21) montiert ist.

8. Kompressor nach einem der vorhergehenden Ansprüche, wobei, wenn die Drosselklappe (40) im Wesentlichen geschlossen ist, ein kleiner Spalt oder ein Leck verbleibt, der/das einen gewissen Zustrom vom Lufteinlass (11) erlaubt.

Revendications

1. Compresseur à air à piston alternatif sans huile (10) comprenant :

un orifice d'admission d'air (11) et un orifice de refoulement d'air comprimé (17) ;
au moins un étage de piston (14a, b, c) raccordé à l'orifice d'admission d'air (11) par une soupape d'admission (30) et à l'orifice de refoulement d'air comprimé (17) par une soupape de refoulement (32) ;
un moteur (12) entraînant l'étage de piston (14a, b, c) ;
une commande des gaz réglable (40) raccordée entre l'orifice d'admission d'air (11) et la soupape d'admission (30),
caractérisé en ce que

le compresseur (10) comprend en outre un dispositif de commande (52) commandant le moteur et la commande des gaz, le dispositif de commande commandant un cyclage de marche/arrêt du moteur (12) d'après des conditions captées par une entrée de capteur ;
moyennant quoi le dispositif de commande (52) est configuré pour fermer sensiblement la commande des gaz (40) pour décharger l'étage de piston (14a, b, c) pour un redémarrage du moteur (12).

2. Compresseur selon la revendication 1, dans lequel la commande des gaz (40) est une vanne papillon.

3. Compresseur selon la revendication 1, dans lequel le compresseur (10) comporte deux étages de piston (14a, b, c) ; et la commande des gaz (40) se trouve entre l'orifice d'admission d'air (11) et la soupape d'admission (30) du premier étage de piston (14b, c).

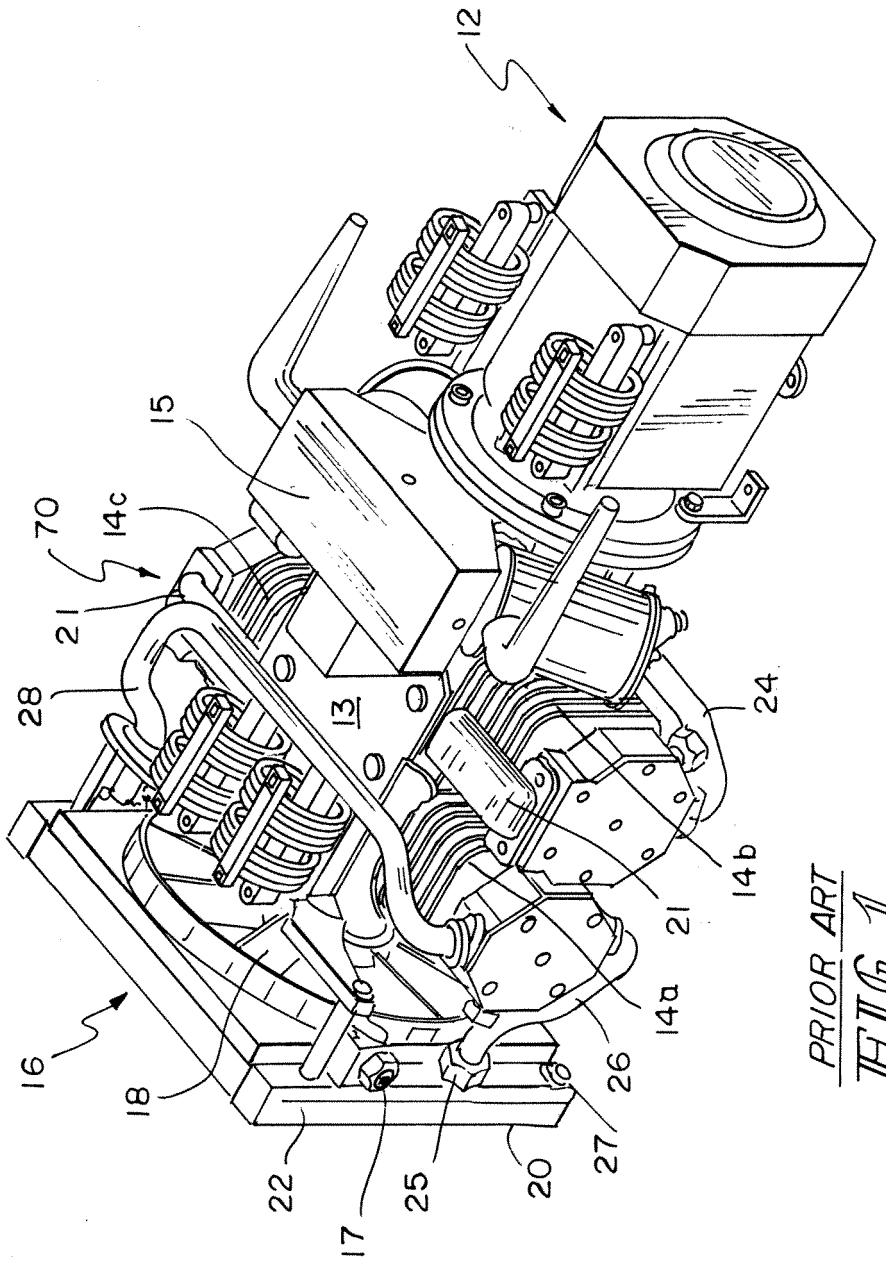
4. Compresseur selon la revendication 1, dans lequel le compresseur (10) comporte un carter de vilebrequin (13) sur lequel l'étage de piston (14a, b, c) et l'orifice d'admission d'air (11) sont montés; et la commande des gaz (40) est montée dans un conduit (21) raccordant le carter de vilebrequin (13) à la soupape d'admission (30).

5. Compresseur selon la revendication 1, dans lequel l'étage de piston (14a, b, c) comporte deux pistons raccordés en parallèle et chaque piston comporte une commande des gaz réglable (40) raccordée à la soupape d'admission (30).

6. Compresseur à air sans huile selon l'une quelconque des revendications précédentes, dans lequel l'orifice d'admission d'air (11) est raccordé à un carter de vilebrequin (13) et dans lequel l'au moins un étage de piston (14a, b, c) est monté sur le carter de vilebrequin (13), la soupape d'admission (30) est raccordée à l'orifice d'admission d'air (11) par le conduit (21) ; et dans lequel la commande des gaz réglable (40) se trouve dans le conduit (21) entre le carter de vilebrequin (13) et la soupape d'admission (30).

7. Compresseur selon la revendication 6, dans lequel l'étage de piston (14a, b, c) comporte deux pistons raccordés en parallèle, et chaque piston comporte une commande des gaz réglable (40) montée dans le conduit (21) raccordant la soupape d'admission (30) et le carter de vilebrequin (13).

8. Compresseur selon l'une quelconque des revendications précédentes, dans lequel lorsque la commande des gaz (40) est sensiblement fermée, une petite fissure ou fuite subsiste permettant une certaine entrée depuis l'orifice d'admission d'air (11).



PRIOR ART
FIG. 1

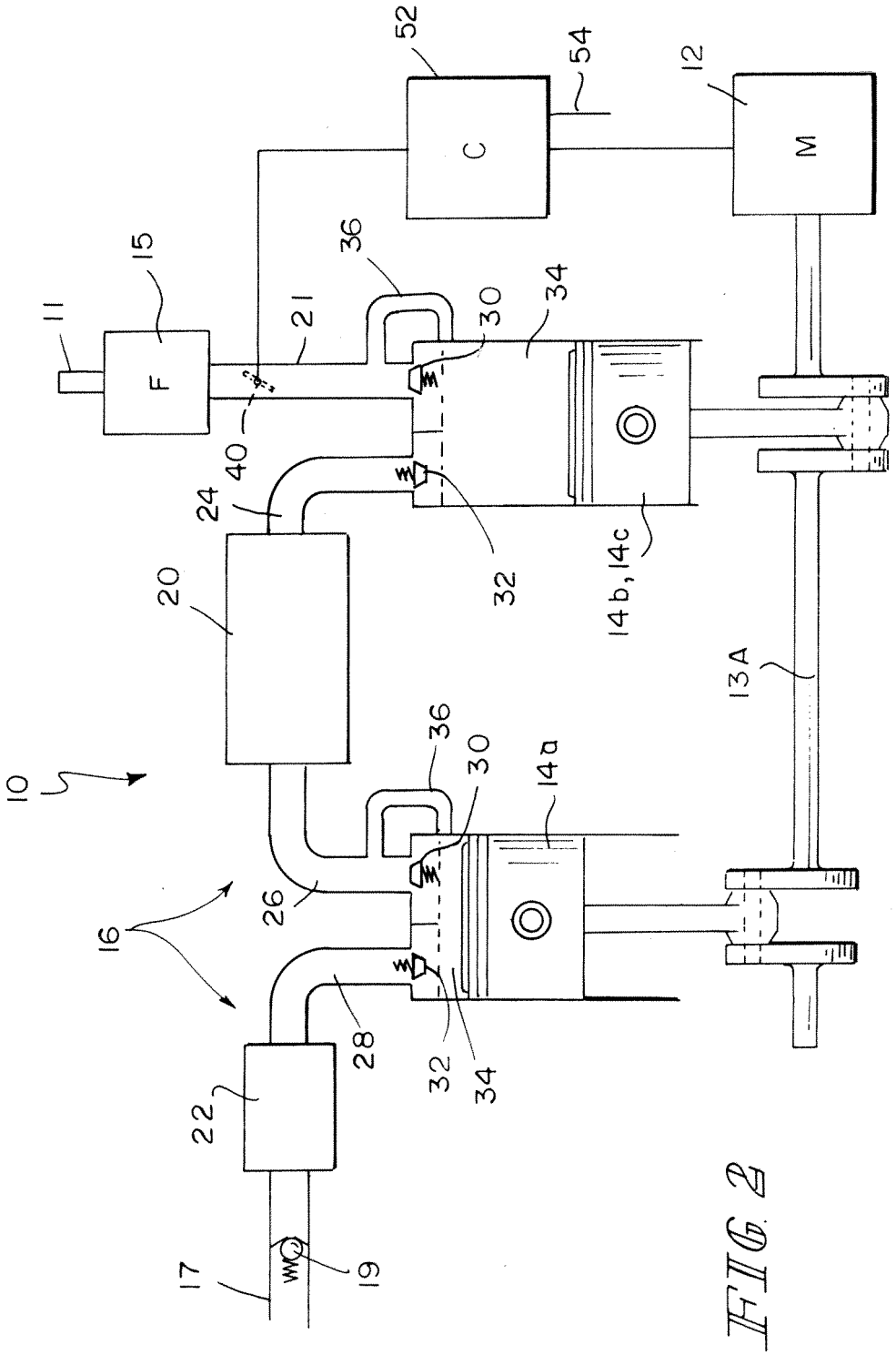

52
54
12
C
M
15
36
11
21
30
34
F
40
24
32
14b, 14c
20
13A
10
36
30
14a
16
26
28
32
34
22
17
19

FIG 2

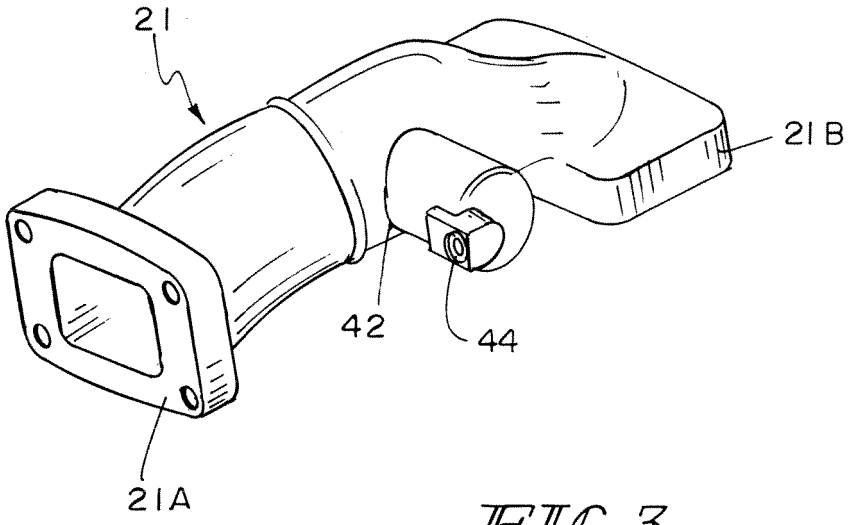


FIG. 3

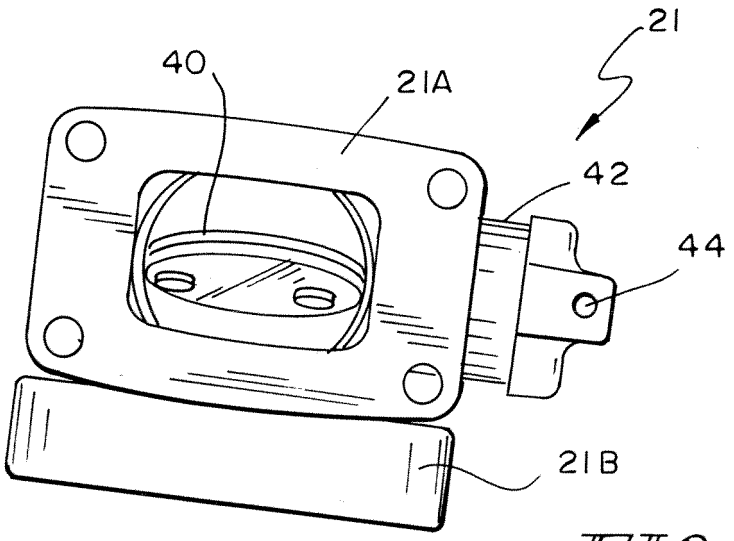


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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