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Description

This invention relates to gas compressors and relates more especially but not exclusively to piston and cylinder air compressors in which the ultimate pressure of the delivered compressed air is limited by operation of an unloader valve.

In the GB-A-1334394 it has been proposed to limit the output pressure of a compressor by introducing additional clearance volume. In a particular example of a compressor in which the delivered pressure is limited by added clearance volume, the compressor is provided with an unloader valve having a pressure responsive control member subject to delivered pressure. The control member is biased by the force of a spring so that the unloader valve remains closed until a pre-determined pressure is reached, it acts on the pressure responsive member to unseat the unloader valve and thereby add a small volume to the clearance volume above the head of the compressor piston. One shortcoming of such an arrangement is that the unloader valve may be so sensitive as to open and close for small fluctuations of the delivered pressure. Indeed, the valve may tend to open and close for each cycle of the compressor piston at times when the delivered pressure is at or near the predetermined value.

In the DE-A-2818482 there is proposed an alternative compressor arrangement wherein instead of inlet and delivery valves being provided in a cylinder head as shown in the above document, these valves are reed valves on a valve plate and an unloader valve is also provided which has a valve member engageable with the upper surface of the valve plate. Here again, the unloader valve is subject to compression chamber pressure in a sense such that oscillation may occur during transitions between loaded and unloaded conditions of the compressor. In the case of the German O.L.S. the compression chamber is connected to atmosphere during unloaded conditions.

Owing to the designs of the prior art arrangements it has been found that not only is there a tendency to oscillate but also such designs are prone to inefficient operation, namely undesired heating particularly when the unloader valve is used to connect additional clearance volume.

The object of the present invention is therefore to provide an improved Gas Compressor apparatus in which the aforementioned shortcomings are reduced.

According to the present invention there is provided gas compressor apparatus comprising a compression member which reciprocates in a compression chamber having, a head assembly with a first main portion and a second cover portion which is separable from said first main portion, said head assembly including an inlet valve, a delivery valve an additional clearance volume and an unloader valve having pressure responsive valve actuating means and a stem and the unloader valve being urged by a spring bias into engagement with a valve seat in a passage between said compression chamber and said additional clearance volume said unloader valve when closed isolating the additional clearance volume from said compression chamber and enabling said compression member alternately to induce gas through said inlet valve and to compress said induced gas to a desired pressure for delivery through said delivery valve to a receiver and said unloader valve when opened by the actuating means acting on said stem against the spring bias in response to a control signal serving to interrupt the said delivery by connecting said additional clearance volume to said compression chamber characterised in that said valve seat is formed in an inner surface of the said compression chamber and the actuating means comprise a pressure responsive member which is arranged to have a first area responsive to a pressure signal at a control port from a governor device which senses attainment of preset pressure in the receiver to move said unloader valve inwardly of said chamber against said spring bias, and said pressure responsive actuating means has a second smaller area subject to the pressure in the additional clearance volume and is separate from but operatively linked to the unloader valve.

In order that the invention may be more clearly understood and readily carried into effect, the same will be further described by way of example with reference to the accompanying drawings of which:-

Fig. 1 illustrates, in sectional view, parts of an air compressor and system employing the present invention,

Fig. 2 illustrates a modification of the air compressor shown in Fig. 1, and

Fig. 3 illustrates a further modification of the gas compressor of Fig. 2 affording reduced overall height.

Referring to the drawing, a reciprocating piston air compressor has a cylinder a fragment of which is indicated at reference 1, having a bore 2 and a piston 3 sealingly slideable therein. The cylinder 1 is provided with a valve plate 4 with delivery and inlet valves 4b and 4a together with a cylinder head assembly comprising a first main portion 5 and a second cover portion 6 which is separable from 5 for ease of manufacture, assembly and subsequent maintenance of a further poppet valve denoted by reference 7 which operates as an unloader valve.

The cylinder head has an induction chamber 8 communicating with a compression chamber 9 above the piston via the inlet valve 4a and deliv-
ered air under pressure from the region 9 passes through the delivery valve 4b to a delivery port 10 for supplying to a receiver comprising a storage reservoir 11. The pressure stored in the reservoir 11 is communicated via a pipe 12 to utilisation means such as a brake system. The pressure in the line 12 is sensed by a governor device 13 which typically is a governor type D2 as marketed by Applicant and described for example in their Technical Pamphlet 4/002. A pressure signal is derivable from the governor 13 on attainment of a preset pressure in the receiver and connected to a control input port 14 which communicates with a first larger area 15 of pressure responsive actuating means comprising a stepped piston 16 with seals 17 and 18. The region between seals 17 and 18 is vented via a small passage 26 (shown dotted) to atmosphere. The opposing face 19 of the piston 16 is engageable with inward end 20 of a stem 7a of the unloader valve 7 which is located in a valve guide 21 and has a head 22 engageable with a seat 23 formed in the cylinder head portion 5 and therefore is formed in the inner surface of the compression chamber 9. The valve 7 is biased into the closed position shown by a frusto-conical spring 24 acting between the guide 21 and a collet 25 retained on the stem by a suitable circlip or cotter 29 in an annular groove. Enclosed within the cylinder head assembly between parts 5 and 6 there is provided an additional clearance volume 27 which communicates via apertures 28 in the valve guide 21 and unseated valve 7, with the region 9 above the piston. The area presented by the head 22 of the valve to the pressure in the region 9 lies between the area of 19 and the area of 15.

The compressor apparatus operates in a conventional manner drawing air in via induction chamber 8 and delivering compressed air via the delivery port 10 into the storage volume of the reservoir 11, chosen in accordance with the utilisation means; and upon attainment of a selected pressure the governor device 13 applies a pressure signal to the control port 14. The pressure delivered by the governor approximates to the pressure in the reservoir and this acts on the first upper area 15 of the piston 16 to thereby urge the valve member against the action of spring 24 and the pressure in chamber 9 which acts on the area of 22, such that the valve is rapidly unseated. Opening of this further valve connects the extra clearance volume provided by region 27 with the volume of the chamber 9. The volume of 27 is approximately twenty times the minimum volume of chamber 9, typically 100 cubic centimetres. Under these conditions, the maximum pressure attained in the chamber 9 immediately drops to a value which is appreciably less than the former delivery pressure and pressure in the reservoir 11, so that the compressor now ceases to deliver compressed air. There is then a cyclic pressure fluctuation accompanied by flow of air backwards and forwards via the unseated valve 22 between the regions 9 and 27 as the piston 3 cyclically varies the volume 9. The valve 7 remains unseated as the pressure fluctuations acting upon the smaller area of the piston 16 are insufficient to move the piston against the control pressure acting on the larger area thereof.

In the compressor apparatus described in the foregoing with reference to Fig. 1, there is a possibility of pressure fluctuations in the compression chamber 9 of the compressor causing the valve 7 to chatter against its seat whilst the signal pressure at the control port 14 is increasing or decreasing through a small critical band of pressures within which the valve 7 is to be operated either to unload or reinstate the compressor operation. A modification of the arrangement of Fig. 1, designed to reduce or prevent such valve chatter, is illustrated in Fig. 2 in which corresponding passages, ports, volumes and components are given the same reference numerals as those of Fig. 1. The main additional feature of Fig. 2 resides in that the pressure responsive actuator means comprises a piston 36 which is of extended length in its upper portion. Piston 36 is provided with two 'O' ring seals 37 and 38. The signal passage from the control signal input port 14 now communicates via an annular region 40 between seals 37 and 28 and a choked flow passage 39 in the piston with the upper area 41 of the extended piston. The portion of the piston 36 which carries the seal 38 has a somewhat reduced diameter compared with the area 15 of piston 16 of Fig. 1 and the portion of piston 36 which carries seal 37, in order that it may conveniently be accommodated in a bore 43 formed in a screwed-in closure cap 42 which therefore needs to be of no greater diameter than the closure cap of Fig. 1.

In operation of the compressor arrangement of Fig. 2, assume initially that the compressor is operating to deliver pressure via the delivery port 10 to reservoir 11, the pressure in reservoir 11 attains a pressure value which is sensed by the governor 13 as being the preset normal operating pressure for the system which is supplied by the reservoir, the governor 13 communicates a control pressure to port 14. Depending upon the characteristics of the governor and the lengths and diameters of the flow paths involved for the control pressure signal, the pressure applied to the piston 36 may be subject to a progressive increase but since this is applied via choked passage 39 a small volume exists above the area 41 of the piston which, with choked passage 39, is effective to damp the effects of pulsating flow through the valve 7, when the
valve is being unseated. Chatter of the head 22 of the valve 7 against its seat 23 is, therefore, substantially prevented or reduced. Similarly, during release of signal pressure from port 14, when the governor determines that the compressor is required to go "on-load" again, the volume of air above the piston area 41 again serves to act against the valve 7, until a sufficient pressure reduction occurs to enable the valve to close completely against its seat 23 under the action of spring 24, assisted finally by an upward compression stroke of the compressor piston.

In each of the arrangements described in the foregoing, the poppet unloader valve is operated by an actuating piston which is aligned with and above it whereas for some applications the additional height requirement imposed by the presence of such an actuating piston may be unacceptable. In a further embodiment of the invention, as illustrated in Fig. 3, the cylinder head assembly height requirement for accommodating the actuating piston may be further reduced by locating the actuating piston alongside the valve, rather than above it and arranging a suitable rocker arm linkage between them.

Referring to Fig. 3, similar references are applied to corresponding components already referred to.

The cylinder head assembly comprises a valve plate 4, a first main part 63 and a cover part 64. The actuator now comprises a piston 66 sealingly slideable in a cylindrical bore 67 formed in the part 68 of the cylinder head assembly and alongside the poppet valve 7. The piston 66 is similar to piston 36 of Fig. 2 and the portion including the choked passage 68 includes a recess 72 for a light spring 73 and is sealingly slideable in a suitable plug 69, which closes the lower end of the cylinder 67. A rocker 70 is pivoted on a spindle 71 captive in the cylinder head such that upward movement of the piston 66 acts through the rocker arm 70 against the upper end of the stem 7a of the valve 7 whereby the valve 7 is operable in the same way as described previously, upon application of a governor signal to an annular region 64. Spring 73 prevents unnecessary rattle.

In embodiments such as those of Figs. 1, 2 and 3 when using materials most conventionally used for cylinder heads and valves, it is found that it is preferable to have the periphery of the head (e.g. 22 in Fig. 1) of curved section and the seat which receives it is conveniently frusto-conical.

An advantage of unloading a compressor by means such as provided by the invention is that of a compact assembly. Oil carryover from the compression chamber of the compressor may be minimised by maintaining pressure above the piston 3 even when the compressor is "off load" and this is now rendered achievable in a practical way by the features by which the invention is defined in the foregoing. Compressor cooling waterways, air passages and volumes can be accommodated without an undesirably bulky construction.

Furthermore, by having additional clearance volume which is contained by the parts of the cylinder head assembly and which is connectable by virtue of a poppet unloader valve such as 7 operated more particularly by pressure responsive actuating means controlled by a governor device, the possibility of the valve member being actuated by pressure fluctuation in the chamber 9 is substantially removed. It is also to be seen that a pressure responsive member such as 16, 36 and 68, with its relatively large area subject to the governor signal and its relatively small area subject to the pressure in the additional clearance volume, the latter pressure is normally unable to significantly affect the action of the said member.

Although not described herein by way of an embodiment of the invention, it will be appreciated that the governor may if desired be incorporated on the cylinder head or even in part integrated with the actuating means of the poppet unloader valve. Again, the control signal which operates the actuating means may as an alternative be other than a fluid pressure signal, for example, an electrical signal to operate electrical signal responsive actuator means.

Claims

1. Gas compressor apparatus comprising a compression member (3) which reciprocates in a compression chamber (9) having a head assembly with a first main portion (5) and a second cover portion (6) which is separable from said first main portion, said head assembly including an inlet valve (4a), a delivery valve (4b) an additional clearance volume (27) and an unloader valve (7) having pressure responsive valve actuating means (16; 36; 66) and a stem (7a) and the unloader valve being urged by a spring (24) bias into engagement with a valve seat (23) in a passage between said compression chamber (9) and said additional clearance volume (27) said unloader valve when closed isolating the additional clearance volume (27) from said compression chamber (9) and enabling said compression member (3) alternately to induce gas through said inlet valve (4a) and to compress said induced gas to a desired pressure for delivery through said delivery valve (4b) to a receiver (11) and said unloader valve (7) when opened by the actuating means (16; 36; 66) acting on said stem (7a) against the spring bias in re-
sponse to a control signal serving to interrupt
the said delivery by connecting said additional
clearance volume (27) to said compression
chamber (9) characterised in that said valve
seat (23) is formed in an inner surface of the
said compression chamber (9) and the actu-
ating means comprise a pressure responsive
member (16; 36; 66) which is arranged to have
a first area responsive to a pressure signal at a
control port (14) from a governor device (13)
which senses attainment of preset pressure in
the receiver (11) to move said unloader valve
(7) inwardly of said compression chamber (9)
against said spring (24) bias, and said pres-
sure responsive actuating means has a second
smaller area subject to the pressure in the
additional clearance volume (27) and is sepa-
rate from but operatively linked to the unloader
valve (7).

2. Gas compressor apparatus as claimed in claim
1 characterised in that said valve actuating
means (16; 36; 66) are contained by said parts
of said head assembly and said unloader valve
(7) when closed.

3. Gas compressor apparatus as claimed in claim
1 or 2, characterised in that the unloader valve
(7) has a circular head (22) with a curved
annular seating surface and said valve seat
(23) is a frusto-conical seat for receiving said
head.

4. Gas compressor apparatus as claimed in claim
1 or 2 characterised in that the stem (7a)
extends axially from the head (22) through a
valve guide (21) located in the first portion (5),
said valve guide (21) being provided with fluid
flow apertures (28) spaced around said stem
(7a).

5. Gas compressor apparatus as claimed in claim
4, characterised in that said pressure responsive
member (16; 36) is located in said second
portion (6) and is axially aligned with said stem
(7a).

6. Gas compressor apparatus as claimed in claim
4, characterised in that said pressure responsive
member (66) is located in said head as-
ssembly to operate said unloader valve (7) via a
pivoted rocker arm (70).

7. Gas compressor apparatus as claimed in claims
1-6, characterised in that said pressure
responsive member is a piston (16) having a
first relatively large pressure responsive area
(15) subject to said fluid pressure control sig-
nal and a second relatively small opposing
area subject to fluid pressure in said additional
clearance volume and via which said unloader
valve is mechanically operated.

8. Gas compressor apparatus as claimed in claim
7 characterised in that said actuator comprises
a piston having a first area subject to control
pressure changes at a control pressure port
(14) and a further area communicating with
said first area via a choked passage (39) and a
third relatively small opposing area subject to
the pressure in the additional clearance volume
(27) via which said unloader valve is mecha-
nically operated.

Patentansprüche

1. Gaskompressorvorrichtung, umfassend einen
Kompressionskammer (9) hin- und herbewegt, die
ein Kopfgebilde hat mit einem ersten Hauptteil
(5) und einem zweiten Abdeckteil (6), der von
dem ersten Hauptteil trennbar ist, wobei das
Kopfgebilde ein Einlaßventil (4a), ein Abgabe-
ventil (4b), ein zusätzliches Spielvolumen (27)
und ein Abladungventil (7) umfaßt, welches
eine auf Druck ansprechende Ventiltätli-
gungseinrichtung (16;36;66) und einen Stößel
(7a) hat, wobei das Abladungventil durch eine
Feder (24) in Eingriff mit einem ventilätz (23)
in einem Durchgang zwischen der Kompres-
sionskammer (9) und dem zusätzlichen Spiel-
volumen (27) vorgespannt ist und, wenn es
geschlossen ist, das zusätzliche Spielvolumen
(27) von der Kompressionskammer (9) trennt
und es dem Kompressionsteil (3) ermöglicht,
abwechselnd Gas durch das Einlaßventil (4a)
hindurch einzusaugen und das eingesaugte
Gas auf einen gewünschten Druck zu kompri-
mieren für Abgabe durch das Abgabevventil
(4b) an einen Empfänger (11), und wobei das
Abladungventil (7), wenn es von der Betäti-
gungseinrichtung (16;36;66) geöffnet wird, auf
den Stößel (7a) gegen die Federvorspannung
beim Ansprechen auf ein Steuersignal wirkt,
was dazu dient, die Abgabe zu unterbrechen
durch verbinden des zusätzlichen Spielvolumens
(27) mit der Kompressionskammer (9),
dadurch gekennzeichnet, daß der Ventilsitz
(23) in einer inneren Fläche der Kompressions-
kammer (9) gebildet ist und die Betätigungs-
einrichtung einen auf Druck ansprechenden
Teil (16;36;66) aufweist, der so angeordnet ist,
daß eine erste Fläche auf ein Drucksignal an
einer Steueröffnung (14) von einer Regelerein-
richtung (13) anspricht, welche das Erreichen
Gaskompressorvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Ventilbetätigungs einrichtung (16; 36; 66) und das zusätzliche Spielvolumen (27) durch die genannten Teile des Kopfgebildes und das Entladungsventil (7), wenn dieses geschlossen ist, umschlossen sind.

2. Gaskompressorvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Ventilbetätigungs einrichtung (16; 36; 66) und das zusätzliche Spielvolumen (27) durch die genannten Teile des Kopfgebildes und das Entladungsventil (7), wenn dieses geschlossen ist, umschlossen sind.

3. Gaskompressorvorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das Entladungsventil (7) einen kreisförmigen Kopf (22) mit einer gekrümmten ringförmigen Sitzfläche hat und der Ventilsitz (23) ein kegelstumpfförmiger Sitz zum Aufnehmen des Kopfes ist.

4. Gaskompressorvorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Stößel (7a) sich von dem Kopf (22) axial erstreckt durch eine Ventilführung (21), die in dem genannten ersten Teil (5) angeordnet und mit Fluidströmungsoffnungen (28) versehen ist, die rund um den Stößel (7a) im Abstand angeordnet sind.

5. Gaskompressorvorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß der auf Druck ansprechende Teil (16; 36) in dem genannten zweiten Teil (6) angeordnet und mit dem Stößel (7a) axial ausgerichtet ist.


7. Gaskompressorvorrichtung nach den Ansprüchen 1 bis 6, dadurch gekennzeichnet, daß der auf Druck ansprechende Teil ein Kolben (16) ist mit einer ersten relativ großen auf Druck ansprechenden Fläche (15), die dem Fluiddrucksteuersignal unterworfen ist, und mit einer zweiten relativ kleinen gegenüberliegenden Fläche, die dem Fluiddruck in dem zusätzlichen Spielvolumen unterworfen ist und über die das Entladungsventil mechanisch betätigt wird.


Revendications

1. Appareil compresseur de gaz comprenant un organe compresseur (3) mobile en va-et-vient dans une chambre de compression (9) comprenant un ensemble de tète avec une première partie principale (5) et une deuxième partie de couvercle (6) qui est séparable de la première partie principale, cet ensemble de tète comprenant un clapet d’admission (4a), un clapet de refoulement (4b), un volume libre additionnel (27) et une soupape de déchargement (7) associée à des moyens d’actionnement (16; 36; 66) de soupape sensible à la pression et une tige (7a), la soupape de déchargement étant chargée par un ressort (24) contre un siège de soupape (23) dans un passage situé entre ladite chambre de compression (9) et ladite volume libre additionnel (27), ladite soupape de déchargement, lorsqu’elle est formée, isolant le volume libre additionnel (27) de la chambre de compression (9) et autorisant ledit organe compresseur (3) alternativement à aspirer du gaz à travers ledit clapet d’admission (4a) et à comprimer le gaz admis jusqu’à une pression désirée ou le refouler à travers ledit clapet de refoulement (4b) vers un récepteur (11), et ladite soupape de déchargement (7), lorsqu’elle est ouverte par les moyens d’actionnement (16; 36; 66) agissant sur ladite tige (7a) contre la charge du ressort en réponse à un signal de commande qui sert à interrompre ledit refoulement par une mise en connection du volume libre additionnel (27) et de la chambre de compression (9), caractérisé en ce que ledit siège de soupape (23) est formé sur une surface interne de ladite chambre de compression (9) et en ce que les moyens d’actionnement comprennent un organe sensible à la pression (16; 36; 66) qui est agencé de manière à présenter une première surface sensible à un signal de pression à un orifice de commande (14) et venu d’un dispo-
sitif régulateur (13) qui détecte l'apparition d'une pression préréglée dans le récepteur (11) pour déplacer ladite soupape de déchargement (7) vers l'intérieur de la chambre de compression (9) contre la charge du ressort (24), et en ce que ledit organe d'actionnement sensible à la pression présente une deuxième surface plus petite soumise à la pression dans le volume libre additionnel (27) et est séparé de la soupape de déchargement (7) tout ou partie de l'ensemble de tète et ladite soupape de déchargement (7) lorsqu'elle est formée.

2. Appareil compresseur de gaz conforme à la revendication 1, caractérisé en ce que lesdits moyens d'actionnement de soupape (16; 36; 66) et le volume libre additionnel (27) sont contenus par lesdites parties de l'ensemble de tête et ladite soupape de déchargement (7) lorsqu'elle est formée.

3. Appareil compresseur de gaz conforme à l'une quelconque des revendications 1 ou 2, caractérisé en ce que la soupape de déchargement (7) présente une tète circulaire (22) avec une surface de siège annulaire incurvée, ledit siège de soupape (23) étant un siège tronconique propre à recevoir ladite tète.

4. Appareil compresseur de gaz conforme à l'une quelconque des revendications 1 ou 2, caractérisé en ce que la tige (7a) s'étend axialement à partir de la tète (22) à travers un guide de soupape (21) disposé dans la première partie (5), ledit guide de soupape (21) étant muni de passages de fluide (28) disposés autour de ladite tige (7a).

5. Appareil compresseur de gaz conforme à la revendication 4, caractérisé en ce que ledit organe sensible à la pression (16, 36) est disposé dans ladite deuxième partie (6) et est axialement aligné avec ladite tige (7a).

6. Appareil compresseur de gaz conforme à la revendication 4, caractérisé en ce que ledit organe sensible à la pression (66) est disposé dans ledit ensemble de tète pour faire fonctionner ladite soupape (7) de déchargement par l'intermédiaire d'un bras basculant articulé (70).

7. Appareil compresseur de gaz conforme aux revendications 1 à 6, caractérisé en ce que ledit organe sensible à la pression est un piston (16) présentant une première surface (15) relativement grande, sensible à la pression et soumise au signal de commande de pression de fluide et une deuxième surface oppo-

8. Appareil compresseur de gaz conforme à la revendication 7, caractérisé en ce que ledit actionneur comprend un piston présentant une première surface soumise à des changements de pression de commande à un orifice de pression de commande (14) et une autre surface en communication avec ladite première surface à travers un passage étranglé (39), et une troisième surface opposée relativement petite soumise à la pression dans le volume libre additionnel (27), ladite soupape de déchargement étant mécaniquement actionnée par ledit piston.