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(54) Method of controlling a plurality of compressors

Verfahren zum steuern von mehreren Verdichtern

Procede de commande de plusieurs compresseurs

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Description

[0001] The present invention relates to a method of controlling a plurality of compressors according to claim 1.

[0002] Japanese Patent No.2,875,702 discloses a method of controlling a plurality of compressors in a system in which compressed gases from a plurality of compressors are gathered into a pressure tank of which a required compressed gas is taken out.

[0003] When compressed gases outputted from compressors are supplied into a pressure tank of which the compressed gas is taken out in use, the compressors frequently start and stop, which results in failure in the compressors and burning damage in a motor if difference in pressure between the upper and lower limits is small.

[0004] Accordingly, with increase in the volume of the pressure tank, the upper limit of pressure is kept to 0.2 MPa higher than used pressure to increase difference between the upper and lower limits.

[0005] However, in this method, it operates for a long time to increase driving power thereby increasing running costs. The compressors are continuously operated at a high pressure to cause decrease in lives of the compressors.

[0006] Furthermore, rotation speed of the compressor is set depending on high upper limit pressure and it is necessary to decrease rotation speed during normal operation. So it operates with decreased amount of air, thereby decreasing efficiency of the compressors.

[0007] The compressors are cooled with cooling fans driven at low rotation speed thereby decreasing cooling effect. Thus, it causes decrease in lives of tip seals and bearings. Another prior art method is disclosed in US 6266952.

SUMMARY OF THE INVENTION

[0008] In view of the above disadvantages, it is an object of the invention to provide a method of controlling operation of compressors to increase the number of the compressors operated at low pressure closer to the lower limit and to decrease the number of the compressors operated at higher temperature closer to the upper limit, time for operation being decreased to decrease running costs to improve the lives of the compressors, tip seals and bearings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The above and other features and advantages of the invention will become more apparent from the following description with respect to embodiment as shown in appended drawings wherein:

Fig. 1 is a view which shows one embodiment of the present invention; and
Fig. 2 is a graph which shows a change in pressure to compressors in Fig. 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] Fig. 1 illustrates one embodiment of the present invention.

[0011] Compressed gases, such as compressed air, outputted from a plurality of compressors are gathered into a pressure tank. A required amount of compressed air is taken out of the pressure tank and employed. The compressed gases are not always gathered into the pressure tank, but may be taken out of conduits directly.

[0012] In the embodiment as shown in Fig. 1, eight compressors 1 comprising C_1 to C_8 are driven by motors 2 comprising M_1 to M_8 respectively, Electromagnetic switches 3 comprising E_1 to E_8 turn the motors M_1 to M_8 on and off respectively.

[0013] At exits of the compressors 1, check valves 4 comprising V_1 to V_8 are provided to prevent running back of compressed air from the compressors 1 Compressed air through the check valves 4 is all fed into a pressure tank 5, of which compressed air used in an object 7 is taken out by opening and shutting a valve 6. To keep compressed air in the pressure tank 5 at a desired pressure, the compressors 1 are controlled on the basis of feedback by determination of compressed air in the pressure tank 5.

[0014] Pressure of compressed air in the pressure tank 5 is measured by a pressure sensor 8 to generate a pressure signal which is transmitted to a control 9 which has a determining portion 10 for determining the number of operating compressors and a selecting portion 11 for starting and stopping any of the compressors. Based on the pressure signal measured by the pressure sensor 8, the determining portion 10 determines the number of the operating compressors 1. Generally, the operating compressors are determined depending on the pressure signal between predetermined upper and lower limits.

[0015] In a preferred embodiment, each of the compressors 1 has approximately the same capability, and the pressure between the upper and lower limits are divided into pressure levels which are equal to the compressors 1 in number. The measured pressure signal is out of desired pressure level and reaches to the boundary of the pressure levels, thereby changing the number of the operating compressors 1.

[0016] Specifically, the measured pressure signal increases and reaches to pressure level higher than desired pressure level by one stage. Then, the number which is subtracted by one from the number of the operating compressors 1 is determined as a new number of operating compressors. Meanwhile, the pressure signal decreases and reaches to pressure level lower than desired pressure level by one stage. Then, the number which is added by one to the number of the operating compressors 1 is determined as a new number of operating compressors.

[0017] A signal of the number determined in the determining portion 10 is transmitted to the selecting portion 11 that selects which compressors start or stop. The selection is carried out with predetermined order of starting and stopping. Preferably, numeric order may be allotted to the compressors 1 which start and stop in the order. By the numeric order, any of the compressors 1 equally start and stop to avoid disadvantage that a specific compressor frequently starts and stops or is operating for a long time.

[0018] When the compressor 1 which starts or stops is selected in the selecting portion 11, a signal is transmitted to the operating portion 12 from which it is transmitted to the electromagnetic switches 3 which turn on or off power sources to the corresponding motors 2, so that the compressors 1 selected in the selecting portion 11 start or stop.

[0019] Fig. 2 is a graph that illustrates changes in pressure to the operating compressors 1 when the eight compressors 1 such as C_1 to C_8 are controlled. Compressed air in the pressure tank 5 between the lower limit such as 0.6 MPa and the upper limit such as 0.7 MPa is divided in pressure into eight stages which are equal to the compressors 1 in number to determine each pressure level. The lower and upper limits are set to level 0 and level 8/8 respectively, and 1/8 to 8/8 are set therebetween by dividing equally. Also, for example, desired pressure levels are set to 1/8 to 2/8. Continuous Nos. 1 to 8 are allotted to the eight compressors 1.

[0020] As shown in Fig. 2, first, until a pressure signal 13 measured by the pressure sensor 8 becomes the pressure level 1/8, the eight compressors 1 all run. Pressure rises, the pressure level reaches 1/8 at P1 beyond the lower limit 0, and a stop signal is transmitted from the control 9 to the electromagnetic switch E_1 of the compressor No.1 (C_1) via the operating portion 12 to stop the compressor No.1. The seven compressors Nos. 2 to 8 still run.

[0021] Pressure rises without compressed air to reach the pressure level 2/8 at P2, and then a stop signal is transmitted to the electromagnetic switch E_2 for the compressor No.2 (C_2) from the control 9 via the operating portion 12 to stop the compressor No.2. The six compressors Nos. 3 to 8 still run.

[0022] Pressure rises slightly without compressed air. Before it becomes the next pressure level 3/8, compressed air is used and the pressure level falls to 1/8 at P3, and a start signal is transmitted from the control 9 to the electromagnetic switch E_1 for the compressor No.1 (C_1) which initially stops, via the operating portion 12, so that the compressor No.1 starts. Thus, the seven compressors No.1 and Nos. 3 to 8 still run.

[0023] With compressed air, the pressure level falls, but does not reach 0. Thereafter, compressed air is not used, and pressure reaches to 2/8 at P4 again beyond the pressure level 1/8. A stop signal is transmitted to the electromagnetic switch E_3 for the compressor No.3 (C_3) from the control 9 via the operating portion 12. Thus, the six compressors No. 1 and Nos.4 to 8 still run.

[0024] Compressed air is not used and the pressure level rises to 3/8 at P5. A stop signal is transmitted from the control 9 to the electromagnetic switch E_4 for the compressor No.4 (C_4) via the operating portion 12 to stop the compressor No.4. The five compressors No.1 and Nos. 5 to 8 still run.

[0025] Compressed air is not used and pressure rises, so that the pressure level reaches to 4/8 at P6. A stop signal is transmitted from the control 9 to the electromagnetic switch E_5 for the compressor No.5 (C_5) via the operating portion 12 to stop the compressor No.5. The four compressors No.1 and Nos. 6 to 8 still run.

[0026] Compressed air is not used and pressure rises, so that the pressure level reaches to 5/8 at P7. A stop signal is transmitted from the control 9 to the electromagnetic switch E_6 for the compressor No.6 (C_6), which stops. The three compressors Nos. 1, 7 and 8 still run.

[0027] Compressed air is not used, and pressure rises, so that the pressure level reaches to 6/8 at P8. A stop signal is transmitted from the control 9 to the electromagnetic switch E_7 for the compressor No.7 (C_7) via the operating portion 12 to stop the compressor No.7. The two compressors Nos. 1 and 8 still run.

[0028] Compressed air is not used and the pressure level rises, so that the pressure level reaches to 7/9 at P9. A stop signal is transmitted from the control 9 to the electromagnetic switch E_8 for the compressor No.8 (C_8) via the operating portion 12 to stop the compressor No.8. Only the compressor No.1 still runs.

[0029] Compressed air is not used and pressure rises, so that the pressure level reaches to 8/8 at P10. A stop signal is transmitted from the control 9 to the electromagnetic switch E_1 for the compressor No.1 (C_1), which stops. All the compressors do not run.

[0030] While compressed air is used and the pressure level falls below 7/8, all the compressors do not run yet.

[0031] Compressed air is used and the pressure level falls to 7/8 at P11. A start signal is transmitted from the control 9 to the electromagnetic switch E_2 for the compressor No.2 (C_2) which secondly stops, via the operating portion 12, to start the compressor No.2. The seven compressors No. 1 and Nos. 2 to 8 do not run yet.

[0032] Compressed air is used, and the pressure level falls to 6/8 at P12. A start signal is transmitted from the control 9 to the electromagnetic switch E_3 for the compressor No.3 (C_3) which thirdly stops, via the operating portion 12, to start

the compressor No.3. The compressors No. 1 and Nos.4 to 8 do not run yet.

[0033] Compressed air is used and the pressure level falls to 5/8 at P13. A start signal is transmitted from the control 9 to the electromagnetic switch E_4 for the compressor No.4 (C_4) which stops fourthly, via the operating portion 12 to start the compressor No.4. The five compressors No.1 and Nos. 5 to 8 do not run.

[0034] Compressed air is used and the pressure level falls to 4/8 at P14. A start signal is transmitted from the control 9 to the electromagnetic switch E_5 for the compressor No.5 (C_5) which stops fifthly, via the operating portion 12 to start the compressor No.5. The compressors No.1 and Nos.6 to 8 do not run yet.

[0035] Compressed air is used and the pressure level falls to 3/8 at P15. A start signal is transmitted from the control 9 to the electromagnetic switch E_6 for the compressor No. 6 (C_6) which stops sixthly, via the operating portion 12 to start the compressor No.6. The three compressors Nos. 1, 7 and 8 do not run.

[0036] Compressed air is used and the pressure level fall to 2/8 at P16. A start signal is transmitted from the control 9 to the electromagnetic switch E_7 for the compressor No.7 (C_7) which stops seventhly, via the operating portion 12 to start the compressor No.7. The two compressors Nos. 1 and 8 do not run yet.

[0037] Compressed air is used and the pressure level fall to 1/8 at P17. A start signal is transmitted from the control 9 to the electromagnetic switch E_8 for the compressor No.8 (C_8) which stops eighthly, via the operating portion to start the compressor No.8. Only the. compressor No. 1 does not run yet.

[0038] Compressed air is used and the pressure level falls to 0/8 at P18. A start signal is transmitted from the control 9 to electromagnetic switch E_1 for the compressor No.1 (C_1) which stops ninthly, via the operating portion 12 to start the compressor No.1. All the compressors Nos. 1 to 8 run, and there is no compressor that does not run.

[0039] The foregoing merely relate to embodiments of the invention. Various changes and modifications may be made by a person skilled in the art without departing from the scope of claims.

Claims

1. A method of controlling a plurality of compressors (1), comprising the steps of:

   gathering compressed gases outputted from said plurality of compressors (1) which have approximately the same capabitity;
   measuring pressure of a compressed gas thus gathered to transmit a pressure signal to control said plurality of compressors (1),
   dividing the pressure of the compressed gas between upper and lower limits into a plurality of pressure levels which are equal in number to said compressors (1); **characterised in that** the pressure signal is transmitted to a control (9) which has a determining portion (10) for determining a number of operating compressors (1) and a selecting portion (11) for starting and stopping any of the compressors; wherein the method further comprises the steps of:

      determining the number of operating compressors when the pressure signal reaches the boundary of said pressure levels; and
      starting or stopping a compressor by a signal of the number transmitted to the selecting portion, wherein the selection of compressor which starts or stops is carried out by a predetermined order of starting and stopping.

2. A method as claimed in claim 1 wherein the compressed gases are gathered into a pressure tank (5) from said plurality of compressors.

3. A method as claimed in claim 1 wherein the pressure of the gathered compressed gas is measured by a pressure sensor (8) to generate a pressure signal.

4. A method as claimed in claim 1 wherein the compressed gas is air.

5. A method as claimed in claim 5 wherein the pressure signal is transmitted from the control (9) to electromagnetic switches (3) via an operating portion, (12) said electromagnetic switches being connected to motors (2) for said compressors to turn on and off said compressors.

6. A method as claimed in claim 1 wherein the pressure rises to an upper pressure level to decrease the number of operating compressors, while the pressure falls to a lower pressure level to Increase the number of operating compressors.

7. A method as claimed in claim 1 wherein continuous numbers are allotted to said plurality of compressors, any of the compressors being started and stopped in order of the numbers to change the number of operating compressors.

Patentansprüche

1. Verfahren zur Steuerung einer Mehrzahl von Kompressoren (1), welches folgende Schritte aufweist:

   Sammeln der komprimierten Gase, die aus der Mehrzahl von Kompressoren (1), die ungefähr das gleiche Leistungsvermögen haben, ausgegeben werden;
   Messen des Drucks des derart gesammelten komprimierten Gases, um ein Drucksignal zur Steuerung der Mehrzahl von Kompressoren (1) zu übermitteln;
   Aufteilen des Drucks des gemessenen Gases zwischen oberen und unteren Grenzen in eine Mehrzahl von Druck-Niveaus, welche in der Anzahl gleich zu der Mehrzahl von Kompressoren (1) sind;
   dadurch gekennzeichnet, dass
   das Drucksignal zu einer Steuerung (9) übermittelt wird, welche einen Bestimmungs-Teil (10) zur Bestimmung einer Anzahl von arbeitenden Kompressoren (1) und einen Auswahl-Teil (11) zum Starten und Anhalten jedes Kompressors aufweist;
   wobei das Verfahren weiterhin folgende Schritte aufweist:

      Bestimmung der Anzahl der arbeitenden Kompressoren, wenn das Drucksignal die Grenze der Druck-Niveaus erreicht;
      und Starten oder Anhalten eines Kompressors durch ein Nummernsignal, das zum Auswahl-Teil (11) übermittelt wird, wobei die Auswahl des Kompressors, der gestartet oder angehalten wird, durch eine vorher festgelegte Reihenfolge des Startens und Anhaltens ausgeführt wird.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die komprimierten Gase in einem Druck-Tank (5) von der Mehrzahl von Kompressoren gesammelt werden.

3. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Druck des gesammelten komprimierten Gases durch einen Drucksensor (8) zum Erzeugen eines Drucksignals gemessen wird.

4. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das komprimierte Gas Luft ist.

5. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das Drucksignal von der Steuerung (9) über einen Arbeits-Teil (12) zu elektromagnetischen Schaltern (3) übertragen wird, und die elektromagnetischen Schalter (3) mit Motoren (2) der Kompressoren (1) verbunden sind, um die Kompressoren (1) ein- und auszuschalten.

6. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Druck zu einem oberen Druckniveau steigt, um die Anzahl der arbeitenden Kompressoren (1) zu verringern, während der Druck zu einem niedrigen Druckniveau sinkt, um die Anzahl der arbeitenden Kompressoren (1) zu erhöhen.

7. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Mehrzahl von Kompressoren (1) fortlaufende Nummern zugeordnet sind, wobei jeder der Kompressoren (1) in der Reihenfolge der Nummern gestartet oder angehalten wird, um die Anzahl der arbeitenden Kompressoren (1) zu ändern.

Revendications

1. Procédé de commande d'une pluralité de compresseurs (1), comprenant les étapes de :

   rassembler les gaz comprimés délivrés en sortie de ladite pluralité de compresseurs (1) qui ont approximativement la même capacité ;
   mesurer la pression d'un gaz comprimé ainsi rassemblé pour transmettre un signal de pression pour commander ladite pluralité de compresseurs (1) ;
   diviser la pression du gaz comprimé entre des limites supérieure et inférieure dans une pluralité de niveaux de pression qui sont égaux au nombre desdits compresseurs (1),
   caractérisé en ce que le signal de pression est transmis à une commande (9) qui a une partie de détermination

(10) pour déterminer un nombre de compresseurs (1) fonctionnant et une partie de sélection (11) pour démarrer et arrêter n'importe lesquels des compresseurs, dans lequel le procédé comprend, en outre, les étapes de :

déterminer le nombre de compresseurs fonctionnant quand le signal de pression atteint la limite desdits niveaux de pression, et
démarrer ou arrêter un compresseur par un signal du nombre transmis à la partie de sélection, dans lequel la sélection du compresseur qui démarre ou s'arrête est mise en oeuvre par un ordre prédéterminé de départ et d'arrêt.

2. Procédé selon la revendication 1, dans lequel les gaz comprimés sont rassemblés dans un réservoir de pression (5) à partir de ladite pluralité de compresseurs.

3. Procédé selon la revendication 1, dans lequel la pression du gaz comprimé rassemblé est mesurée par un détecteur de pression (8) pour générer un signal de pression.

4. Procédé selon la revendication 1, dans lequel le gaz comprimé est de l'air.

5. Procédé selon la revendication 4, dans lequel le signal de pression est transmis de la commande (9) aux commutateurs électromagnétiques (3) par l'intermédiaire d'une partie d'actionnement (12), lesdits commutateurs électromagnétiques étant reliés aux moteurs (2) à partir desdits compresseurs pour activer et désactiver lesdits compresseurs.

6. Procédé selon la revendication 1, dans lequel la pression s'élève à un niveau de pression supérieur pour réduire le nombre de compresseurs fonctionnant tandis que la pression chute à un niveau de pression inférieur pour augmenter le nombre de compresseurs fonctionnant.

7. Procédé selon la revendication 1, dans lequel des nombres continus sont attribués à ladite pluralité de compresseurs, n'importe lesquels des compresseurs étant démarrés et arrêtés en fonction des nombres pour modifier le nombre de compresseurs fonctionnant.

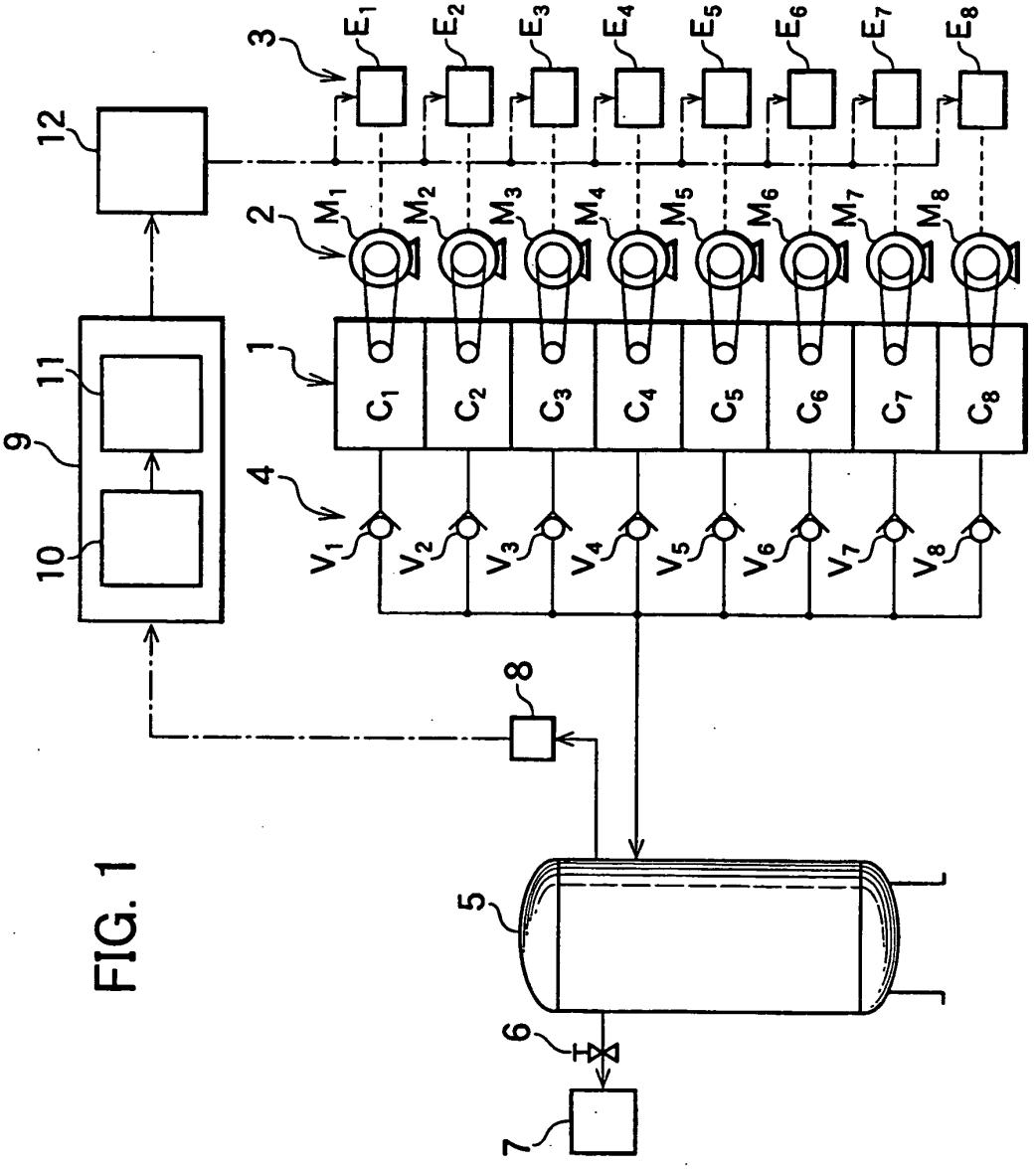
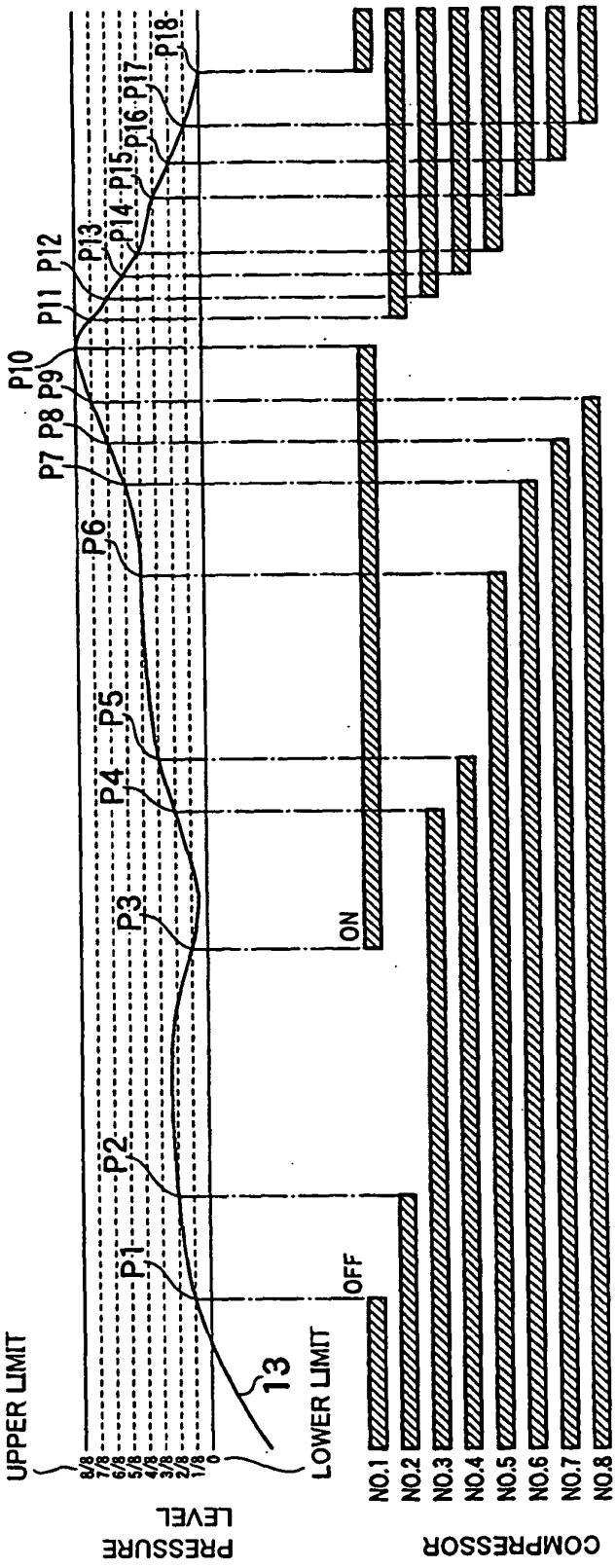

3
E1
E2
E3
E4
E5
E6
E7
E8
12
2
M1
M2
M3
M4
M5
M6
M7
M8
1
C1
C2
C3
C4
C5
C6
C7
C8
9
11
10
4
V1
V2
V3
V4
V5
V6
V7
V8
8
5
L
6
7

FIG. 1

FIG. 2


UPPER LIMIT
LOWER LIMIT
PRESSURE LEVEL
COMPRESSOR
ON
OFF
13
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
NO.1
NO.2
NO.3
NO.4
NO.5
NO.6
NO.7
NO.8