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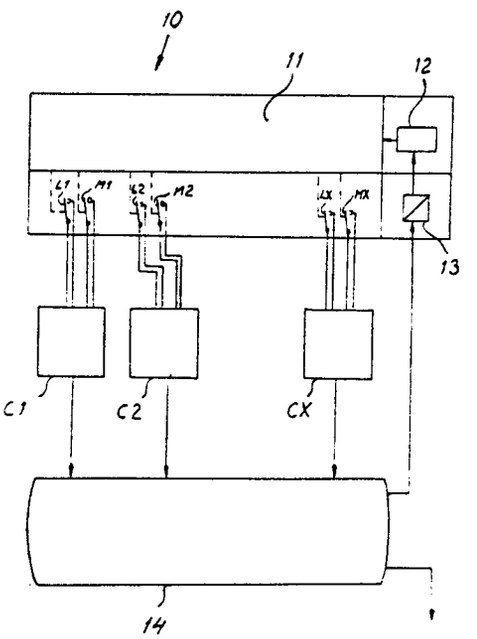
(71) Applicant: **Atlas Copco Aktiebolag**
Nacka
S-105 23 Stockholm(SE)

(72) Inventor: **van Nederkassel, Ludovicus Jacobus**
48, Akkerstraat
B-9360 Buggenhout(BE)

(74) Representative: **Grundfelt, Gunnar et al**
c/o Atlas Copco Aktiebolag Patent Department
S-105 23 Stockholm(SE)

(54) Method of controlling the pressure of a medium delivered by a compressor plant.

(57) A method of controlling the pressure of medium delivered by a compressor plant. The pressure is measured at predetermined time intervals. Each pressure is compared with the next preceding pressure and anumber of compressors (C_1, C_2 ,... C_X) being one less than is needed to change sign of the pressure derivative is switched in or out. One further compressor is switched in or out at the limit pressure.



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A method of controlling the pressure of compressed medium delivered by a compressor plant

The present invention relates to a method of controlling the pressure of compressed medium delivered by a compressor plant where a number of compressors are connected in parallel to a compressed medium network. The connected compressors may have equal or unequal capacities. The consumption of compressed medium may vary irregularly and unpredictably. Each of the compressors is advantageously provided with its own start/stop and/or load/unload regulation, preferably based on the basic ideas mentioned in US 4 135 860.

One prior art solution is the cascade regulation according to which the compressors are switched in or out one after the other when the pressure in the system passes certain predetermined limit pressures. In such control systems the total pressure fluctuations can become quite substantial because there has to be a minimum distance between the limit pressures. This applies in particular to the lower limit pressures where additional compressor capacity is to be added. Otherwise the electrical network may be overloaded if several compressors are to be started at about the same time.

Another prior art method, described in DE 2 412 296, counts the time required for the pressure to vary from a known pressure level to the limit pressure. The speed of pressure variation obtained in this way is used to decide whether one or more compressors should be switched in or out at the pressure limit. Because the corrective action is taken when the pressure limit is reached substantial pressure variations outside the predetermined pressure limits may occur. This applies in particular if two or more compressors have to be started before they can be loaded to deliver compressed medium. Another disadvantage is that measuring the speed of pressure variation by counting the time between two predetermined pressure levels may lead to a value that is not representative at the end of the measuring period. This depends on the fact that if the pressure change is slow the measuring time will be long. During such a long measuring period the speed of pressure variation may change considerably.

The present invention aims at creating a control method according to which the pressure is better kept between desired pressure limits thus avoiding severe pressure drops below the lower limit pressure when more compressor capacity must be switched in. This is achieved by the method defined in the appended claim 1. In order to obtain a representative value for the speed of variation of the pressure at varying operating conditions of the compressor plant the pressure is measured at predetermined time intervals, e.g. every second. Each measured pressure is compared with the next preceding measured pressure to create a difference value. This value corresponds to the difference between the amount of compressed medium delivered by the compressor plant and the amount of medium used. This means that if the pressure rises more compressed medium is delivered by the compressor plant to the compressed medium network than is used, i.e. taken out of the compressed medium network. The opposite is valid if the pressure falls. In order to avoid too severe pressure excursions outside the desired pressure range the number of compressors delivering compressed medium to the compressed medium network is adapted so that only one more compressor should be required to change medium delivery status when the pressure reaches the limit pressure. By medium delivery status is meant either that the compressor delivers medium, i.e. runs loaded, or that the compressor does not deliver medium, i.e. runs unloaded or is not running. As a consequence of the above a number of compressors being one less than is needed to change sign of the difference between the two last measured pressures are forced to change medium delivery status.

Occasionally the pressure may continue to stay outside the desired pressure range partly because there is a reaction time in the control system but primarily because of changes in the demand for compressed medium. Therefore the pressure measurements are continued outside the desired pressure range and further compressors are forced to change medium delivery status so that the speed of variation of pressure changes sign, i.e. if the pressure is above the upper limit pressure the pressure is forced to decrease and if the pressure is below the lower limit pressure the pressure is forced to increase.

According to an advantageous embodiment of the invention the pressure drop below the lower limit pressure that may occur during the starting up of the next compressor is predicted at each pressure measurement if at decreasing pressure all running compressors are loaded. The time needed for starting up a compressor may be of the order of 5 to 30 seconds depending on compressor size. If the predicted pressure drop exceeds a set value the next compressor is started to run unloaded. After this the medium delivery capacity of the compressor plant can be increased more rapidly.

An embodiment of the invention is described below with reference to the accompanying drawing which shows a control system where the invention is used.

The compressor plant shown in the drawing comprises a number of compressors C1, C2....CX. Each of these compressors is provided with its own control system for starting and stopping of the compressor drive motor and for loading and unloading the compressor in response to electrical commands, e.g. closing or opening of contacts MX or LX respectively. When contact MX closes the compressor will be automatically started and as soon as the compressor has reached its operating speed it may be loaded by the closing of contact LX. Opening of contact LX causes unloading of the compressor. Opening of contact MX results in the stopping of the compressor. Delivery of compressed medium to a compressed medium network 14 is thereby interrupted. The network is here shown as a receiver 14 from which compressed medium can be taken out by a consumer. The compressors of the compressor plant are controlled by a central controller 10. The pressure in the network is sensed by a pressure transducer 13 the output of which is an analogue electrical signal being proportional to the pressure of the compressed medium. The analogue signal is transformed into a digital signal by an analogue to digital converter 12. The digital signal corresponding to the pressure in receiver 14 is supplied to a microcomputer 11, which comprises a microprocessor, memory for storing information about compressor capacities, limit pressures, measured pressures and so on, and drive circuits for actuation of contacts LX and MX.

During operation the pressure in the compressed medium network 14 is measured at predetermined time intervals, e.g. every second. The two latest pressures are stored in mocricomputer 11. These measured pressures are compared to create a difference value which indicates if more or less compressor capacity is needed to balance the consumption of compressed medium. This difference value is compared with the available compressor capacities, stored in the microcomputer, to decide how many compressors should be switched in or out. If the pressure is between the desired limit pressures one compressor less than needed for changing a pressure increase into a pressure decrease or vice versa is switched in or out. The further compressor is switched in or out at the limit pressure. If the pressure is outside the desired range, which could be a result of changes in the consumption of compressed medium, the number of compressors needed in order to change sign of the pressure derivative are switched in or out. If a too severe pressure drop below the lower limit pressure is predicted when all running compressors are loaded a further compressor can be started to run unloaded in order to decrease the time before compressed medium can be delivered.

Claims

1. A method of controlling the pressure of compressed medium delivered by a compressor plant where a number of compressors are connected in parallel to a compressed medium network,

characterized in that the pressure in said compressed medium network is measured at predetermined time intervals, that each measured pressure is compared with the next preceding measured pressure to create a difference value, that said difference value is compared with the capacities of the available compressors, that a number of compressors being one less than is needed to change sign of said difference value are forced to change medium delivery status when the measured pressure lies between two predetermined limit pressures and that one further compressor is forced to change medium delivery status when either limit pressure is reached.

2. A method according to claim 1

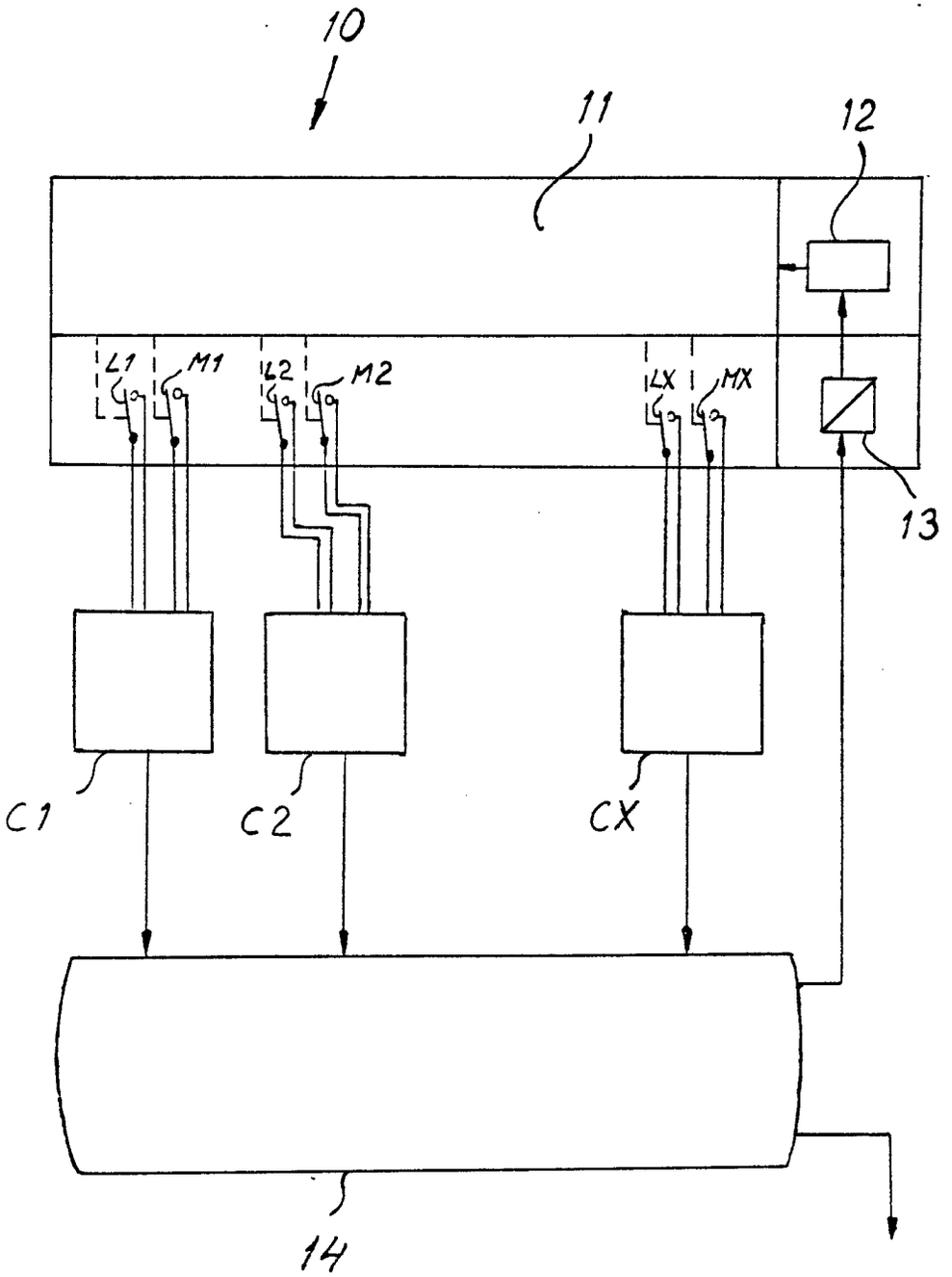
characterized in that said predetermined time intervals are so short that the sampling frequency is higher than the frequency of the pressure variation in the compressed medium network.

3. A method according to claim 1 or 2,

characterized in that as long as the measured pressure is outside any of the two predetermined limit pressures a number of compressors needed to change sign of the pressure derivative is forced to change medium delivery status.

4. A method according to any of the preceding claims,

characterized in that the pressure drop that may occur during the starting up of the next compressor is predicted and that said next compressor is started to run unloaded if said pressure drop exceeds a set value.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L1
M1
L2
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C1
C2
CX
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