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(54) **METHOD AND SYSTEM FOR CONTROLLING A PRESSURIZED FLUID AND VALVE ASSEMBLY FOR USE THEREIN**

VERFAHREN UND SYSTEM ZUR REGELUNG EINER DRUCKFLÜSSIGKEIT UND DAFÜR VERWENDBARE VENTILANORDNUNG

PROCEDE ET SYSTEME DE REGULATION D'UN FLUIDE SOUS PRESSION ET ENSEMBLE SOUPAPE UTILISE SELON CE PROCEDE

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US-A- 5 020 564 **US-A- 5 142 483**
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Description**Technical Field**

[0001] This invention relates to methods and systems for controlling pressurized fluids, in particular, to closed loop methods and systems for controlling high or low pressure fluids.

Background Art

[0002] U.S. Patent No. 5,114,660 discloses a method and system for the injection molding of plastic articles in an injection molding system including a pneumatically-operated gas compression unit having a high pressure gas receiver. A fluid pressure reducing valve, together with a directional control valve, controlled by a controller reduces the pressure of the high pressure nitrogen gas and communicates the pressurized fluid from the gas receiver to the injection molding system.

[0003] Briefly, gas-assisted injection molding is a thermoplastic molding process which provides stress-free large parts with a class A surface and virtually no sink marks. Gas-assisted injection molding is a low pressure molding process compared to conventional injection molding. In this process, inert gas such as nitrogen is injected into the plastic after it enters a mold. By controlling the gas pressure, the quantity of plastic injected into the mold (short shot) and the rate of gas flow, a predetermined network of hollow interconnected channels is formed within the molded part. The gas pressure remains constant in the network of hollow channels during the molding. This compensates for the tendency of the plastic to shrink at the thicker areas of the molding preventing warpage and reducing stress. The gas pressure is relieved just prior to opening the mold. Because of the relatively low injection pressure, large parts can be molded with substantial reductions in clamp tonnage.

[0004] Consequently, gas supply equipment must provide precise control of pressure, timing and volume of gas which is injected into the part, all of which are important to the control of the gas-assisted injection process.

[0005] In general, prior art valve assemblies exhibit relatively slow response and have a considerable amount of on-board electronics and take up a considerable amount of room, especially when multiple valve assemblies are required to service a number of injection molds or parts of molds.

[0006] In US-A-5,257,640 a system for precisely controlling gas under high pressure is disclosed, which produces an initial gas pressure in a pressure chamber while applying a predetermined amount of power to a heating element located in the pressure chamber, and then applies a computed change of power to produce an average gas temperature increase or decrease in the pressure chamber, and thereby rapidly produce an increase or decrease in gas pressure with resolution lim-

ited by the resolution of measurement of gas pressure in the pressure chamber and the application of the computed change of power. The system comprises a pair of fluidly-coupled valves, a computer-controlled gas pressure controller connected to the valves and a pressure transducer connected to the pressure chamber and to the computer. The system is capable of stabilizing gas pressure in a volume within about 10 seconds. In this way, the system generates precise test pressure without overshooting. The stabilized pressure is provided in a closed volume as needed for testing and/or calibrating pressure sensitive devices, such as pressure transducers and the like.

Summary of the Invention

[0007] An object of the present invention is to provide a method and system for controlling a pressurized fluid wherein the resulting regulated pressurized fluid can be used in high or low pressure, fast response applications.

[0008] Another object of the present invention is to provide a method and system for controlling a pressurized fluid wherein the valve assembly of the system has a relatively small amount of on-board electronics, is relatively inexpensive, and also provides a compact structure to allow for multiple valve assemblies in a relatively small space.

[0009] In carrying out the above objects and other objects of the present invention, a method is provided for controlling a pressurized fluid having a first pressure to provide the pressurized fluid at a regulated, desired pressure less than the first pressure, the method comprising the steps of providing a pair of pneumatically-operated, fluidly-coupled valves, and an electric proportioning device for operating the valves, communicating the pressurized fluid to the valves, generating a reference signal representative of the desired pressure, generating a reference control signal based on the reference signal, coupling the reference control signal to the proportioning device to control the pressure of the pressurized fluid regulated by the valves, generating a feedback signal as a function of the actual pressure of the regulated pressurized fluid, generating an error signal based on the difference between the reference signal and the feedback signal, the error signal being representative of a desired amount of fluid pressure change, and generating an error control signal as a function of the error signal to control the proportioning device, the proportioning device, in turn, operating the valves to provide the pressurized fluid at the regulated desired pressure.

[0010] Further in carrying out the above objects and other objects of the present invention, a system is provided for carrying out each of the above method steps.

[0011] The control system for controlling a pressurized fluid having a first pressure to provide the pressurized fluid at a regulated desired pressure less than the first pressure comprises a pair of pneumatically-operat-

ed, fluidly-coupled valves connected to a gas pressure controller which, in turn, is connected to a computer, and a pressure transducer connected to an output of the regulated pressurized fluid, an electric proportioning device coupled to the valves for operating the valves as a function of control signals to control the pressure of the pressurized fluid communicated to and regulated by the valves, means for generating a reference signal representative of the desired pressure, feedback means for generating a feedback signal as a function of actual pressure of the regulated pressurized fluid, means for generating an error signal as a function of the difference between the reference signal and the feedback signal, the error signal being representative of a desired amount of pressurized fluid change, and a controller for initially generating a reference control signal based on the reference signal and then generating an error control signal as a function of the error signal to control the electric proportioning device, the proportioning device, in turn, operating the valves to provide the pressurized fluid at the regulated desired pressure.

[0012] Preferably, each of the valves is a pilot operated pneumatic valve and the proportioning device is a pneumatic servovalve for communicating a pneumatic control signal to each of the valves in response to the electrical control signal to control the opening and closing of the valves to, in turn, regulate the pressure of the pressurized fluid.

[0013] Also preferably, in one embodiment the pressurized fluid is a high pressure fluid such as nitrogen gas having a pressure in the range of about 70 bar to 1400 bar (1,000-20,000 psi) for use in a gas-assisted injection molding system. In another embodiment the pressurized fluid has a pressure capable of controlling robots and actuators.

[0014] The advantages according to the method and system of the present invention are numerous. For example, the method and system are capable of operating in high or low pressure, fast response pressure control applications. Furthermore, the valve assembly of the system has fewer on-board electronics and exhibits considerable cost savings over competitive assemblies. Finally, the valve assembly of the system is relatively compact and allows for the use of multiple valve assemblies in a relatively small space.

[0015] The above objects and other objects, features, and advantages of the present invention are readily apparent from the following detailed description of the best mode for carrying out the invention when taken in connection with the accompanying drawings.

Brief Description of the Drawings

[0016] FIGURE 1 is a schematic block diagram illustrating the method, system and valve assembly of the system; and

[0017] FIGURE 2 is a schematic front elevational view of the valve assembly of the system of the present in-

vention.

Best Mode For Carrying Out The Invention

[0018] Referring now to the drawing figures, there is illustrated in Figure 1 in block diagram form, a method, system and valve assembly of the system constructed with the present invention to control a high pressure fluid such as a nitrogen gas which is stored in a high pressure air supply or receiver 10. The high pressure nitrogen gas may be stored in a gas pressure receiver such as illustrated in U. S. Patent No. 5,114,660 at a pressure of about 70 bar to 1400 bar (1,000-20,000 psi). As described in U. S. Patent No. 5,114,660, the gas is stored at high pressure to provide a ready source of high pressure gas for use in a gas-assisted injection mold or system, as illustrated at 12 in Figure 1 and as described in U.S. Patent No. 5,114,660. However, it is to be understood that the method, system and valve assembly can be used to supply low pressure (i.e. approximately 6 bar [80 psi]) fluid for use in robotic or actuator control. The method and system provide the pressurized gas at a regulated desired pressure less than the pressure at which the gas is stored as is described in greater detail hereinbelow.

[0019] In general, the valve assembly of the system includes a pneumatic servovalve, generally indicated at 14, or other air or gas operated proportional valve. The valve assembly also includes first and second pneumatically-operated, fluidly-coupled valves generally indicated at 16 and 18, respectively. The valves 16 and 18 are piloted or controlled along control lines 20 and 22, respectively, by the servovalve 14. Fittings 23 secure the lines 20 and 22 to the servovalve 14 and the valves 16 and 18.

[0020] Each of the pneumatic valves 16 and 18 includes an actuator section 24 and 26, respectively, which includes a diaphragm which responds to a pneumatic control signal on its respective control line. The control signals from the servovalve 14 control the opening and closing of the valves 16 and 18 to thereby regulate the pressure of the high pressure nitrogen gas.

[0021] Each of the pneumatic valves 16 and 18 also includes an inlet port 25, an outlet port 27 and a control port 29 for receiving control signals from the servovalve 14. The inlet port 25 of the first valve 16 opens or closes in response to the control signal received at its input port 29. In like fashion, the outlet port 27 of the second valve 18 opens or closes in response to the control signal received at its input port 29.

[0022] Preferably, the pneumatic servovalve is an Atchley air servo having Model No. 204PN500S/NO60. Also preferably, each of the pilot-operated pneumatic valves is a Dragon air-operated two-way valve having Model No. 85C053KV.

[0023] The two-way valves 16 and 18 are plumbed together by a means or assembly 31 for fluidly communicating the outlet port 27 of the pneumatic valve 16 with

the inlet port 25 of the pneumatic valve 18. The assembly 31 is preferably an HIP cross assembly including a high pressure cross 32 and a number of adapters 34 to fluidly connect the cross 32 to the valves 16 and 18 and a pressure sensor 40. An adaptor 34 also fluidly connects an outlet port 36 of the cross 32 to the system 12.

[0024] While the pneumatic servovalve 14 is gas or air operated, it operates electronically in a closed loop system. A feedback mechanism such as the pressure sensor or transducer 40 is capable of generating a feedback signal as a function of the actual pressure of the regulated high pressure fluid at the cross assembly 31. The pressure sensor 40 supplies the signal along line 42. The fluid pressure signal is representative of the actual pressure of the regulated high pressure fluid. The fluid pressure signal is typically amplified by an amplifier 44 of a controller, generally indicated at 46. Then the amplified signal is set along a line 48 where it is subtracted from a reference signal at a junction block 50. Typically, the reference signal is output by a reference block 52 which may be a manual setting on the controller 46. The reference signal represents the desired pressure for the high pressure nitrogen gas to be utilized by the system 12.

[0025] The junction block 50, in turn, generates an error signal on a line 54 which is utilized by a servovalve drive circuit 56 of the controller 46. The servovalve drive circuit 56 utilizes the error signal appearing on the line 54 to output to the pneumatic servovalve 14 an appropriate error control signal to drive the pneumatic servovalve 14.

[0026] Preferably, the controller 46 is located remotely from the valve assembly.

[0027] Briefly, the pneumatic servovalve 14 initially receives an electrical reference control signal from the controller 46 based on a value set by the reference block 52. In response to the electrical control signal, the pneumatic servovalve 14 allows a proportionate amount of pneumatic pressure into the actuator sections 24 and 26 of the valves 16 and 18, respectively. The two-way valves 16 and 18, in turn, open or close in order to either let high pressure in at the inlet port 25 of the valve 16 from the high pressure air supply 10 or let pressure out in a form of nitrogen gas exhausted at the outlet port of the valve 18. The actual pressure of the regulated high pressure gas which is sent to the system 12 is read by the pressure sensor 40 and fed back to the controller 46 to provide feedback control.

[0028] Then, the feedback signal is utilized with the reference signal to generate an error signal at the junction 50. The error signal is representative of a desired amount of fluid pressure change. The drive circuit 56 uses the error signal which drives the servovalve 14.

[0029] As previously mentioned, the method and system have numerous advantages. For example, control electronics are not located on-board the valve assembly. This has the benefit of allowing electronics to be mounted in a less hazardous environment for increased

reliability. Furthermore, the valve assembly is more cost effective than existing valve assemblies. Finally, the compactness of the valve assembly allows for the mounting of multiple valve assembly in a confined space to service multiple gas-assisted injection molding systems.

Claims

1. A method for controlling a pressurized fluid having a first pressure to provide the pressurized fluid at a regulated desired pressure less than the first pressure, the method comprising the steps of:
 - a) providing a pair of pneumatically-operated, fluidly-coupled valves (16, 18) and
 - b) an electric proportioning device (14) for operating the valves (16, 18);
 - c) communicating the pressurized fluid to the valves (16, 18);
 - d) generating a reference signal representative of the desired pressure;
 - e) generating a reference control signal based on the reference signal;
 - f) coupling the reference control signal to the proportioning device (14) to control the pressure of the pressurized fluid regulated by the valves (16, 18);
 - g) generating a feedback signal as a function of actual pressure of the regulated pressurized fluid;
 - h) generating an error signal based on the difference between the reference signal and the feedback signal, the error signal being representative of a desired amount of fluid pressure change; and
 - i) generating an error control signal as a function of the error signal to control the proportioning device (14),
 - j) the proportioning device (14), in turn, operating the valves (16, 18) to provide the pressurized fluid at the regulated desired pressure.
2. The method of claim 1 wherein the step of generating the feedback signal includes the step of measuring the actual pressure of the regulated pressurized fluid with a pressure transducer (40) to obtain a fluid pressure signal.
3. The method of claim 1 wherein each of the valves (16, 18) is a pilot-operated pneumatic valve.
4. The method of claim 3 wherein the proportioning device (14) is a pneumatic servovalve for communicating a pneumatic control signal to each of the valves (16, 18) in response to the reference and error control signals to control the opening and closing

of the valves (16, 18) to, in turn, regulate the pressure of the pressurized fluid.

5. The method of claim 1 wherein the pressurized fluid is nitrogen gas having a pressure in the range of about 70 bar to 1400 bar (1,000-20,000 psi) for use in a gas-assisted injection molding system (12).

6. The method of claim 1 wherein the pressurized fluid has a pressure capable of controlling robots and actuators.

7. A control system for controlling a pressurized fluid having a first pressure to provide the pressurized fluid at a regulated desired pressure less than the first pressure, the control system comprising:

- a pair of pneumatically-operated, fluidly-coupled valves (16, 18) connected to a gas pressure controller (14) which, in turn, is connected to a controller (46), and a pressure transducer (40) connected to an output (36) of the regulated pressurized fluid,

characterized by

- an electric proportioning device (14) coupled to the valves (16, 18) for operating the valves (16, 18) as a function of control signals to control the pressure of the pressurized fluid communicated to and regulated by the valves (16, 18),
- means (52) for generating a reference signal representative of the desired pressure,
- feedback means (40) for generating a feedback signal as a function of actual pressure of the regulated pressurized fluid,
- means (50) for generating an error signal as a function of the difference between the reference signal and the feedback signal, the error signal being representative of a desired amount of pressurized fluid change, and
- the controller (46) for initially generating a reference control signal based on the reference signal and then generating an error control signal as a function of the error signal to control the electric proportioning device (14), the proportioning device (14), in turn, operating the valves (16, 18) to provide the pressurized fluid at the regulated desired pressure.

8. The control system of claim 7 wherein the feedback means (40) includes a pressure transducer for measuring the actual pressure of the regulated pressurized fluid to obtain a fluid pressure signal.

9. The control system of claim 7 wherein each of the valves (16, 18) is a pilot-operated pneumatic valve.

10. The control system as claimed in claim 9 wherein the proportioning device (14) is a pneumatic servovalve for communicating a pneumatic control signal to each of the valves (16, 18) in response to the control signals to control the opening and closing of the valves (16, 18) to, in turn, regulate the pressure of the pressurized fluid.

11. The control system as claimed in claim 7 wherein the pressurized fluid is nitrogen gas having a pressure in the range of about 70 bar to 1400 bar (1,000-20,000 psi) for use in a gas-assisted injection molding system.

12. The system of claim 7 wherein the pressurized fluid has a pressure capable of controlling robots and actuators.

13. The control system of claim 7 comprising:

- a first valve (16) having an input port (25) adapted to receive the pressurized fluid, an outlet port (27), and a control port (29) adapted to receive a first pneumatic control signal to selectively open and close the input port (25);
- a second valve (18) having an input port (25), an output port (27), and a control port (29) adapted to receive a second pneumatic control signal to selectively open and close the output port (27) of the second valve to exhaust the pressurized fluid;
- means (31) for fluidly communicating the outlet port (27) of the first valve (16) to the inlet port (25) of the second valve (18), said means (31) for fluidly communicating having an output port (36) for communicating the regulated pressurized fluid; and
- an electric proportioning device (14) for providing the first and second pneumatic control signals to control the first and second valves (16, 18), respectively, based on an electrical control signal so that regulated pressurized fluid at the desired pressure is available at the output port of the means (31) for fluidly communicating.

14. The control system as claimed in claim 13 wherein the means (31) for fluidly communicating includes a cross assembly.

Patentansprüche

1. Verfahren zum Beeinflussen eines mit einem ersten Druck unter Druck gesetzten Fluids, um das unter Druck gesetzte Fluid mit einem geregelten, gewünschten Druck, der niedriger als der erste Druck ist, zur Verfügung zu stellen, mit den Schritten:
- Anordnen eines Paares von pneumatisch betätigten, fluidgekuppelten Absperrorganen (16, 18) und
 - eines elektrischen Anpassungsreglers (14) zum Betätigen der Absperrorgane (16, 18);
 - Leiten des unter Druck gesetzten Fluids zu den Absperrorganen (16, 18);
 - Erzeugen eines den gewünschten Druck darstellenden Referenzsignals;
 - Erzeugen eines Referenzregelsignals auf der Grundlage des Referenzsignals;
 - Übermitteln des Referenzregelsignals an den Anpassungsregler (14), um den durch die Absperrorgane (16, 18) geregelten Druck des unter Druck gesetzten Fluids zu steuern;
 - Erzeugen eines Rückkopplungssignals als Funktion des tatsächlichen Drucks des geregelten, unter Druck gesetzten Fluids;
 - Erzeugen eines Fehlersignals auf der Grundlage des Unterschiedes zwischen dem Referenzsignal und dem Rückkopplungssignal, wobei das Fehlersignal einem gewünschten Betrag einer Druckänderung des Fluids entspricht;
 - Erzeugen eines Fehlersteuersignals als Funktion des Fehlersignals, um den Anpassungsregler (14) zu steuern, wobei
 - der Anpassungsregler (14) seinerseits die Absperrorgane (16, 18) ansteuert, um das unter Druck gesetzte Fluid mit dem geregelten, gewünschten Druck zur Verfügung zu stellen.
2. Verfahren nach Anspruch 1, bei dem der Schritt des Erzeugens des Rückkopplungssignals den Schritt umfaßt: Messen des tatsächlichen Drucks des geregelten, unter Druck gesetzten Fluids mit Hilfe eines Druckwandlers (40), um ein Fluidrucksignal zu erhalten.
3. Verfahren nach Anspruch 1, bei dem jedes der Absperrorgane (16, 18) ein ferngesteuertes Pneumatikventil ist.
4. Verfahren nach Anspruch 3, bei dem der Anpassungsregler (14) ein pneumatisches Servoventil ist, das ein pneumatisches Steuersignal an jedes der Absperrorgane (16, 18) als Reaktion auf das Referenzsignal und das Fehlersteuersignal übermittelt, um das Öffnen und Schließen der Absperrorgane (16, 18) und daraus folgend den Druck des unter Druck gesetzten Fluids zu regeln.
5. Verfahren nach Anspruch 1, bei dem das unter Druck gesetzte Fluid Stickstoffgas mit einem Druck im Bereich von ungefähr 70 bar bis 1.400 bar (1.000 bis 20.000 psi) zur Benutzung mit einem System (12) zum Spritzgießen mit Gasunterstützung ist.
6. Verfahren nach Anspruch 1, bei dem das unter Druck gesetzte Fluid einen zum Steuern von Robotern und Betätigungsvorrichtungen geeigneten Druck aufweist.
7. System zum Beeinflussen eines ersten Druck aufweisenden, unter Druck gesetzten Fluids, um das unter Druck gesetzte Fluid mit einem geregelten Druck, der niedriger als der erste Druck ist, zur Verfügung zu stellen, das:
- ein paar pneumatisch betätigte, in Fluidverbindung stehende Absperrorgane (16, 18), die mit einer Gasdrucksteuervorrichtung (14) in Verbindung stehen, wobei die Gasdrucksteuervorrichtung (14) ihrerseits mit einem Regelgerät (46) und mit einem mit einem Ausgang (36) für das geregelte, unter Druck gesetzte Fluid verbundenen Druckwandler (40) in Verbindung steht, umfaßt,
- gekennzeichnet durch**
- einen elektrischen, mit den Absperrorganen (16, 18) verbundenen Anpassungsregler (14) zum Steuern der Absperrorgane (16, 18) in Abhängigkeit von Steuersignalen, um den Druck des den Absperrorganen (16, 18) zugeführten und **dadurch** geregelten, unter Druck gesetzten Fluids zu steuern,
 - eine Einrichtung (52) zum Erzeugen eines den gewünschten Druck darstellenden Referenzsignals,
 - einer Rückkopplungseinrichtung (40) zum Erzeugen eines Rückkopplungssignals in Abhängigkeit vom tatsächlichen Druck des geregelten unter Druck gesetzten Fluids,
 - eine Einrichtung (50) zum Erzeugen eines Fehlersignals in Abhängigkeit von der Differenz zwischen dem Referenzsignal und dem Rückkopplungssignal, wobei das Fehlersignal den gewünschten Betrag der Änderung des unter Druck gesetzten Fluids darstellt, und
 - das Regelgerät (46) zunächst zum Erzeugen eines Referenzsteuersignals auf der Grundlage des Referenzsignals und dann zum Erzeugen eines Fehlersteuersignals in Abhängigkeit

vom Fehlersignal, um den elektrischen Anpassungsregler (14) anzusteuern, wobei der Anpassungsregler (14) seinerseits die Absperrorgane (16, 18) ansteuert, um das unter Druck gesetzte Fluid mit dem geregelten, gewünschten Druck zur Verfügung zu stellen.

8. System nach Anspruch 7, bei dem die Rückkopplungseinrichtung (40) einen Druckwandler zum Messen des tatsächlichen Drucks des geregelten, unter Druck gesetzten Fluids umfaßt, um ein Drucksignal des Fluids zu erhalten. 5
9. System nach Anspruch 7, bei dem jedes der Absperrorgane (16, 18) ein ferngesteuertes Pneumatikventil ist. 10
10. System nach Anspruch 9, bei dem der Anpassungsregler (14) ein pneumatisches Servoventil zum Übermitteln eines pneumatischen Steuersignals an jedes der Absperrorgane (16, 18) in Abhängigkeit von den Steuersignalen ist, um das Öffnen und Schließen der Absperrorgane (16, 18) zu steuern und das daraus folgend den Druck des unter Druck gesetzten Fluids zu regeln. 20
11. System nach Anspruch 7, bei dem das unter Druck gesetzte Fluid Stickstoffgas mit einem Druck im Bereich von ungefähr 70 bar bis 1.400 bar (1.000 bis 20.000 psi) zur Benutzung in einem System zum Spritzgießen mit Gasunterstützung ist. 25
12. System nach Anspruch 7, bei dem das unter Druck gesetzte Fluid eine zum Steuern von Robotern und Betätigungsvorrichtungen geeigneten Druck aufweist. 30
13. System nach Anspruch 7, umfassend:
- ein erstes Absperrorgan (16) mit einer Einlaßöffnung in (25) für das unter Druck gesetzte Fluid, einer Auslaßöffnung (27) und einer Steueröffnung (29) für ein erstes pneumatisches Steuersignal, um die Einlaßöffnung (25) wahlweise zu öffnen und zu schließen; 40
 - ein zweites Absperrorgan (18) mit einer Einlaßöffnung (25) einer Auslaßöffnung (27) und einer Steueröffnung (29) für ein zweites pneumatisches Steuersignal, um die Auslaßöffnung (27) des zweiten Absperrorgans wahlweise zu öffnen und zu schließen und das unter Druck gesetzte Fluid ausströmen zu lassen; 45
 - eine Einrichtung (31) zum Herstellen einer Fluidverbindung zwischen der Auslaßöffnung (27) des ersten Absperrorgans (16) mit der Einlaßöffnung (25) des zweiten Absperrorgans (18), wobei die die Fluidverbindung herstellende Einrichtung (31) eine Auslaßöffnung (36) 50

zum Weiterleiten des geregelten, unter Druck gesetzten Fluids aufweist und

- einen elektrischen Anpassungsregler (14), der das erste und das zweite pneumatische Steuersignal zum Steuern jeweils des ersten und des zweiten Absperrorgans (16, 18) auf der Grundlage eines elektrischen Steuersignals zur Verfügung stellt, so daß das geregelte, unter Druck gesetzte Fluid mit dem gewünschten Druck an der Auslaßöffnung der Einrichtung (31) zum Herstellen einer Fluidverbindung zur Verfügung steht.

14. System nach Anspruch (13), bei dem die Einrichtung (31) zum Herstellen einer Fluidverbindung ein Kreuzstück umfaßt.

Revendications

1. Procédé pour commander un fluide sous pression ayant une première pression pour fournir le fluide sous pression à une pression voulue réglée inférieure à la première pression, le procédé comportant les étapes consistant à :
- a) fournir une paire de vannes (16, 18) accouplées de manière hydraulique et actionnées de manière pneumatique, et
 - b) fournir un dispositif électrique de réglage (14) pour actionner les vannes (16, 18),
 - c) transmettre le fluide sous pression aux vannes (16, 18),
 - d) créer un signal de référence représentatif de la pression voulue,
 - e) créer un signal de commande de référence basé sur le signal de référence,
 - f) accoupler le signal de commande de référence au dispositif de réglage (14) afin de commander la pression du fluide sous pression réglée par les vannes (16, 18),
 - g) créer un signal de rétroaction en fonction de la pression réelle du fluide sous pression réglée,
 - h) créer un signal d'erreur basé sur la différence existant entre le signal de référence et le signal de rétroaction, le signal d'erreur étant représentatif d'une quantité voulue de changement de pression de fluide, et
 - i) créer un signal de commande d'erreur en fonction du signal d'erreur afin de commander le dispositif de réglage (14),
 - j) le dispositif de réglage (14) actionnant à son tour les vannes (16, 18) afin de fournir le fluide sous pression à la pression voulue réglée.
2. Procédé selon la revendication 1, dans lequel l'étape consistant à créer le signal de rétroaction com-

porte l'étape consistant à mesurer la pression réelle du fluide sous pression régulée à l'aide d'un transducteur de pression (40) afin d'obtenir un signal de pression de fluide.

3. Procédé selon la revendication 1, dans lequel chacune des vannes (16, 18) est une vanne pneumatique pilotée.

4. Procédé selon la revendication 3, dans lequel le dispositif de réglage (14) est une servovanne pneumatique destinée à transmettre un signal de commande pneumatique à chacune des vannes (16, 18) en réponse aux signaux de référence et de commande d'erreur afin de commander l'ouverture et la fermeture des vannes (16, 18) afin qu'à leur tour, elles régulent la pression du fluide sous pression.

5. Procédé selon la revendication 1, dans lequel le fluide sous pression est de l'azote gazeux ayant une pression située dans une plage allant d'environ 70 bars à 1400 bars (1000 à 20000 psi), destiné à être utilisé dans un système de moulage par injection assisté par du gaz (12).

6. Procédé selon la revendication 1, dans lequel le fluide sous pression a une pression pouvant commander des robots et des actionneurs.

7. Système de commande destiné à commander un fluide sous pression ayant une première pression pour fournir le fluide sous pression à une pression voulue régulée inférieure à la première pression, le système de commande comportant :

- une paire de vannes (16, 18) accouplées de manière hydraulique et actionnées de manière pneumatique, connectées à un dispositif de commande de pression de gaz (14) qui, à son tour, est connecté à un dispositif de commande (46), et un transducteur de pression (40) connecté à une sortie (36) du fluide sous pression régulée,

caractérisé en ce qu'il comporte :

- un dispositif électrique de réglage (14) accouplé aux vannes (16, 18) pour actionner les vannes (16, 18) en fonction des signaux de commande destinés à commander la pression du fluide sous pression transmise aux vannes (16, 18) et régulée par celles-ci,
- des moyens (52) destinés à créer un signal de référence représentatif de la pression voulue,
- des moyens de rétroaction (40) destinés à créer un signal de rétroaction en fonction de la

pression réelle du fluide sous pression régulée,

- des moyens (50) pour créer un signal d'erreur en fonction de la différence existant entre le signal de référence et le signal de rétroaction, le signal d'erreur étant représentatif d'une quantité voulue de changement de pression de fluide, et

- le dispositif de commande (46) pour créer de manière initiale un signal de commande de référence basé sur le signal de référence, et ensuite créer un signal de commande d'erreur en fonction du signal d'erreur afin de commander le dispositif électrique de réglage (14), le dispositif de réglage (14), à son tour, actionnant les vannes (16, 18) afin de fournir le fluide sous pression à la pression voulue régulée.

8. Système de commande selon la revendication 7, dans lequel les moyens de rétroaction (40) comportent un transducteur de pression pour mesurer la pression réelle du fluide sous pression régulée afin d'obtenir un signal de pression de fluide.

9. Système de commande selon la revendication 7, dans lequel chacune des vannes (16, 18) est une vanne pneumatique pilotée.

10. Système de commande selon la revendication 9, dans lequel le dispositif de réglage (14) est une servovanne pneumatique destinée à transmettre un signal de commande pneumatique à chacune des vannes (16, 18) en réponse aux signaux de commande afin de commander l'ouverture et la fermeture des vannes (16, 18) pour qu'à leur tour, elles régulent la pression du fluide sous pression.

11. Système de commande selon la revendication 7, dans lequel le fluide sous pression est de l'azote gazeux ayant une pression située dans une plage allant d'environ 70 bars à 1400 bars (1000 à 20000 psi) destiné à être utilisé dans un système de moulage par injection assisté par du gaz.

12. Système selon la revendication 7, dans lequel le fluide sous pression a une pression pouvant commander des robots et des actionneurs.

13. Système de commande selon la revendication 7, comportant :

- une première vanne (16) ayant un orifice d'entrée (25) adapté pour recevoir le fluide sous pression, un orifice de sortie (27), et un orifice de commande (29) adapté pour recevoir un premier signal de commande pneumatique pour ouvrir et fermer de manière sélective l'ori-

fice d'entrée (25),

- une seconde vanne (18) ayant un orifice d'entrée (25), un orifice de sortie (27), et un orifice de commande (29) adapté pour recevoir un second signal de commande pneumatique pour ouvrir et fermer de manière sélective l'orifice de sortie (27) de la seconde vanne pour l'échappement du fluide sous pression, 5
- des moyens (31) pour établir une communication de manière hydraulique entre l'orifice de sortie (27) de la première vanne (16) et l'orifice d'entrée (25) de la seconde vanne (18), lesdits moyens (31) destinés à établir une communication de manière hydraulique ayant un orifice de sortie (36) pour transmettre le fluide sous pression régulée, et 10
- un dispositif électrique de réglage (14) pour fournir les premier et second signaux de commande pneumatique destinés à commander les première et seconde vannes (16, 18), respectivement, sur la base d'un signal de commande électrique, de sorte que le fluide sous pression régulée à la pression voulue est disponible au niveau de l'orifice de sortie des moyens (31) destinés à établir une communication de manière hydraulique. 15 20 25

14. Système de commande selon la revendication 13, dans lequel les moyens (31) destinés à établir une communication de manière hydraulique comportent un ensemble en croix. 30

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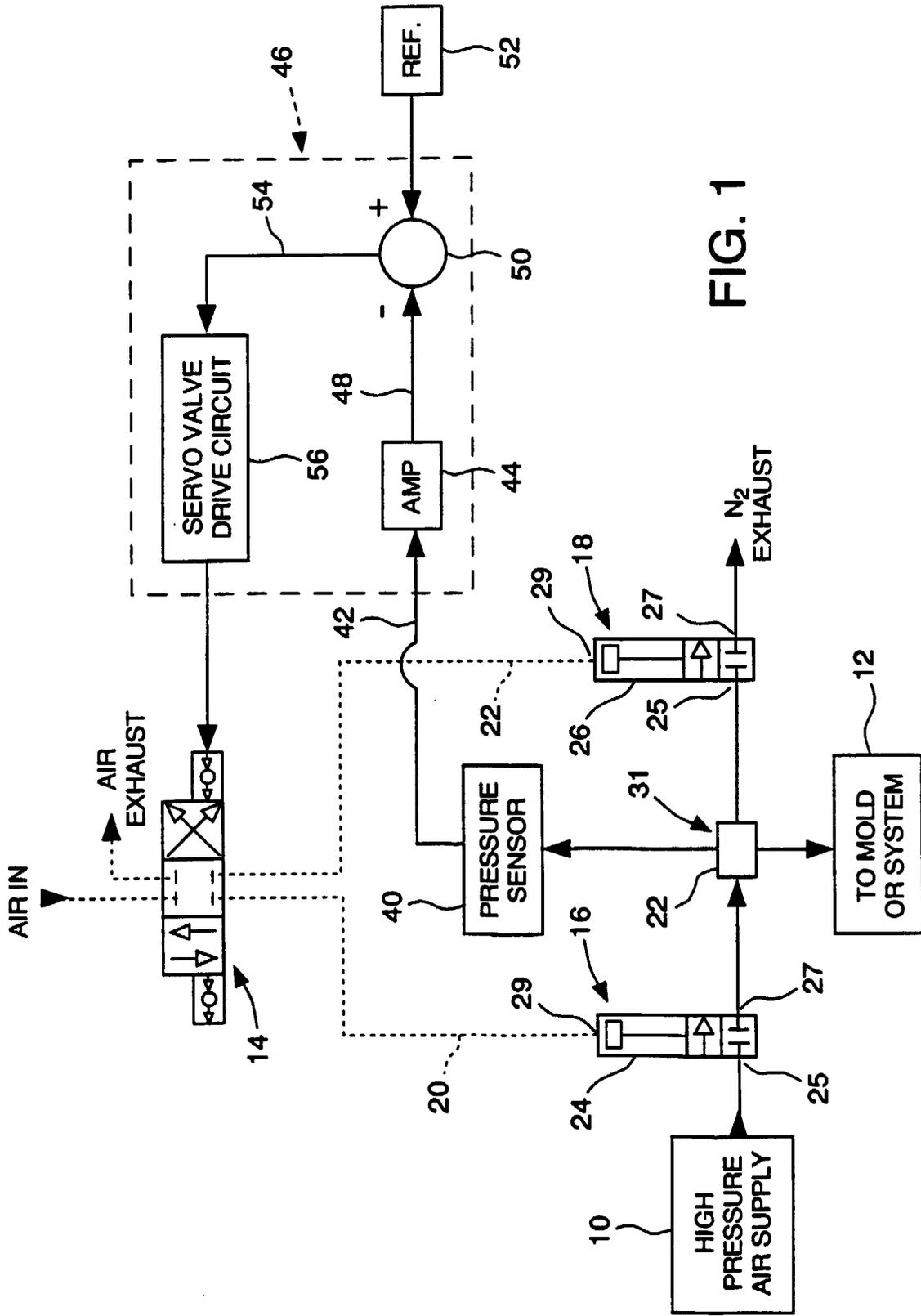


FIG. 1

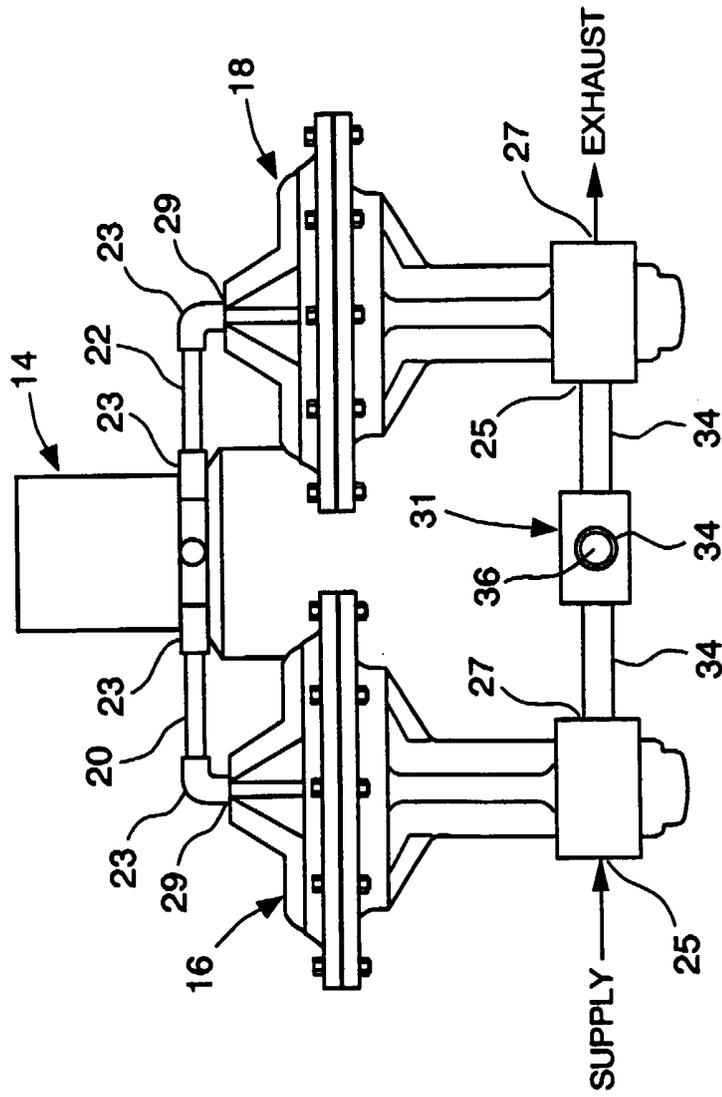


FIG. 2