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(54) **SHIELDING GAS FLOW CONTROLLER FOR A WELDING APPARATUS**

SCHUTZGASSTROMSTEUERUNG FÜR EIN SCHWEISSGERÄT

RÉGULATEUR DE DÉBIT DE GAZ DE PROTECTION POUR APPAREIL DE SOUDAGE

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Description

[0001] The present invention relates to a shielding gas flow controller according to the preamble of claim 1

[0002] Such a shielding gas flow controller is disclosed in WO02/066195 A2.

[0003] For electrical welding operations where the welding point is to be provided with a blanket of inert blanket gas, it is common to provide the blanket gas from a centralized blanket gas supply installation, or from a gas cylinder located in the vicinity of the welding machine unit of the welding apparatus. The blanket gas provided by the supply installation or the gas cylinder typically is provided with a regulated gas pressure that exceeds the pressure at which the blanket gas can be controlled by the blanket gas control means of the welding apparatus. In order to reduce the pressure to level at which the gas conveniently can be delivered to the welding apparatus, and be controlled by a control valve in the welding apparatus switching on and off the flow of blanket gas, a pressure reduction device is inserted in the blanket gas supply line in a location proximal to the gas cylinder or the gas supply installation. Thus, a section of the gas supply line, in which the gas is provided at a lower gas pressure than in the gas supply installation or gas cylinder, exists between the pressure reduction device and the welding machine itself. Typically, this "low pressure" section of the supply line is of a considerable length, in order to allow practical use of the welding machine unit, which often is required to be easily relocateable in order to reach differently located areas at which the welding work is to be performed. Further details with regard to the aspects of the low pressure supply line and the control of blanket gas supply for an electrical welding apparatus is provided in the present applicant Norwegian patent application no. 20021557, and corresponding applications claiming priority from the aforementioned application. In 20021557, a pulse width modulated signal driven valve controlled by the welding wire feed rate takes the place of the traditional shielding gas supply valve in an electrical arc welding apparatus.

[0004] The present applicants co-pending Norwegian patent application no. NO20070472 describes the use of a Pulse Width Modulated PWM valve technique for controlling gas flow.

[0005] For electrical welding operations where the gas flow is regulated according to a welding current and according to the selected welding operation, it is important that the gas flow is held above a minimum level to maintain a good quality of the welding. Aspects that will affect the flow in a gas supply chain, are in general the initial gas pressure and the gas-flow regulation performed by the regulator itself. In addition there may be variable or constant parameters that will affect the gas flow, and these are mainly pressure drop in the supply line both from the regulated gas supply to the regulator, and also pressure drop in the line from the regulator to the point of the gas outlet. It is possibly to add a flow sensor to

measure the actual gas flow, and thereby compensate for the total pressure drop. The disadvantage is that flow sensors are expensive to introduce in a final product, and also the accuracy of the available flow sensors are variable and unpredictable depending on where they are placed in the gas flow line. This variation of accuracy is related to the pulsed gas-flow which interfere with the known flow measurement instruments.

[0006] The present invention describe a method to obtain a gas flow regulation that will overcome problems related to the above mentioned pressure drop. The same problems controlling the gas flow in plasma cutting operations will also be solved using the same regulation technique.

[0007] The present invention provides a gas flow controller for a welding apparatus exhibiting the features recited in the accompanying independent patent claim 1.

[0008] Further advantageous features of the gas flow controller of the invention are recited in the accompanying dependent patent claims 2 - 5.

[0009] A shielding gas flow controller according to the present invention for an electric arc welding apparatus is for insertion into a shielding gas supply line between a shielding gas source and a shielding gas valve of the electric arc welding apparatus. The flow controller has a shielding gas input and a shielding gas output, a controllable gas valve connected between the shielding gas in- and outputs and having a control input, and a controller means having a first input for receiving a welding signal representing an electrical welding arc current of the welding apparatus during a welding operation and a gas flow setting control means adapted to generate a flow setting output being function of the welding signal and representing a desired shielding gas flow. The shielding gas flow controller further comprises an input pressure sensor connected to the shielding gas input and arranged to provide a shielding gas input pressure measurement to a second controller means input, and an output pressure sensor connected to the shielding gas output and arranged to provide a shielding gas output pressure measurement to a third controller means input, and a flow setting output modifying means. The flow setting output modifying means is arranged to modify the flow setting output of the gas flow setting control means based on the shielding gas input and output pressure measurements, the welding signal, and a characteristic of the controllable valve into a control signal for input to the control input of the controllable gas valve so as to maintain during the welding operation a substantially constant shielding gas flow in the shielding gas supply line to the welding apparatus corresponding to the flow setting output substantially independent of actual shielding gas input and output pressures at the shielding gas in- and outputs, respectively.

[0010] The shielding gas flow controller also comprises a means adapted to determine a time at which the welding operation is not being performed on basis of the welding signal, and the controller means is adapted to output

to the controllable gas valve an idle control signal so as to maintain the output pressure at a predetermined idle pressure level substantially during the time at which the welding operation is not being performed.

[0011] Advantageously, in an embodiment of the shielding gas flow controller of the invention, it comprises a gas leak detector means being adapted to be enabled during a period in which the welding operation is not being performed, and being adapted to determine the period on basis of the welding signal or based on output of another device monitoring the welding signal. The gas leak detector means includes a subtractor means arranged to subtract the shielding gas output pressure measurement from the shielding gas input pressure measurement, and to provide a pressure difference value output. A pressure difference comparator has a comparator output, and is arranged to receive on first and second comparator inputs the pressure difference value output and a predetermined pressure difference reference value, respectively. The comparator is adapted to provide on a comparator output a leak indication when the pressure difference value is substantially at or greater than the predetermined pressure difference reference value.

[0012] In a further embodiment of the shielding gas flow controller of the invention, it comprises a pressure level detector receiving the shielding gas input pressure measurement and being adapted to effect provisioning of a valve closing signal to the controllable gas valve so as to close the gas valve when the shielding gas input pressure measurement indicates a gas pressure being at or less than a predetermined shielding gas input pressure minimum level. In the attached drawings,

- Fig. 1 is an overall block schematic of gas flow regulator 100 of the invention in a welding operation
- Fig. 2 is a detailed block schematic of the gas flow regulator 100 of the invention in a Welding operation illustrated in figure 1,
- Fig. 3 is a detailed block schematic of an exemplary embodiment of the gas flow regulator 100 of the invention,
- Fig. 4 is a detailed block schematic of an exemplary embodiment of the control unit of the gas flow regulator 100 of the invention based on a Hardware solution,
- Fig. 5 is an illustration of the physical setup with pressure sensors, valve orifice and flow direction,
- Fig. 6 is a graph illustrating on a time axis the PWM signal with respect to the period T where Ton is representing the valves ON-period,
- Fig. 7 is a block schematic drawing of the table look-up employed by the invention,
- Fig. 8 is a graph showing the flow through an exemplary embodiment of the flow regulator of the invention, the valve operated with a fixed PWM value and a variation of the input pressure from 2 to 6 bar,

Fig. 9 is a graph illustrating gas flow through the valve of the gas regulator of an exemplary embodiment of the invention where the regulation of the PWM according to the value of the pressure sensors are included, and

Fig. 10 is a block schematic drawing showing the gas regulation system of the invention embodied into a plasma cutting machine having two regulated gas flow lines.

[0013] Referring to figures 1 and 2, the invention provides an improvement in gas flow stability, by automatically controlling the average time at which the valve is kept open, thereby reducing flow variations that typically are experienced in prior art welding gas supply installations where gas is supplied from a feeding point 200 that will be placed at a distance away from the regulator 100. In such prior art installations, it is common that the regulator 100 is placed at a considerable distance away from the gas final outlet point 1100. These distances will normally vary from one installation to another installation, and also the dimensions of the supply hoses, tubes, pipes, adapters and connector vary, and the result is that the gas flow level is influenced as shown by the measurement done in Fig. 8, and therefore the flow need to be regulated according to the pressure variations in order to keep the flow level within acceptable tolerances.

[0014] The gas flow controller of the present invention includes pressure sensors at the input (120) and the output (140), respectively, of the "PWM CONTROLLED GAS FLOW REGULATOR" 100. Herein, PWM is an acronym for "Pulse Width Modulated", corresponding to what is disclosed in the co-pending Norwegian patent application no. NO20070472.

[0015] The pulse width controlled gas flow regulator referred to above, in part employed by the present invention, includes a pulse train generator and a pulse train driven valve, typically comprising a solenoid. The pulse train has two states, the ON state (Ton) and the OFF state as described in Fig. 6. The duration (Ton, Toff), i.e. periods, of the aforementioned states may be varied by way one or more inputs to the pulse train generator. The valve is responsive to the aforementioned states, such that the valve assumes a substantially fully open state when driven by the ON state part of the pulse train, and a substantially fully closed state when driven by the OFF state part of the pulse train. By a suitable selection of the pulse repetition frequency of the pulse train, drive power dissipated in the valve is at a minimum, thereby improving the regulator performance.

[0016] In the disclosure of present invention provided herein, including the attached drawings, the pulse train driven valve is referred to by numeral 110, and the pulse train regulator is included as part of the valve controller arrangement being referred to herein by numeral 130.

[0017] With reference to figure 3, some operational aspects of the gas flow controller of the present invention are explained in the following.

[0018] To operate the gas flow controller of the present invention, the initial setting of the desired, or required gas flow level (Q) can either be by a reference input 300 from an operator or a control device, or it can be a measured feedback value 400 from another process that is determining the gas flow requirement.

[0019] An input pressure measurement of P1, at 150 the gas pressure at valve input 120 is fed to the valve controller arrangement 133 to adjust an ON-period 170 of the PWM-controlled valve 110, in order to obtain a constant gas flow 600.

[0020] An output pressure P2 measurement 160 of gas pressure at valve output 140 is used to provide a compensation for a reduction of the gas flow that typically is caused by constant or variable changes in the shape, such as cross section or length of the gas flow line, being constituted by hoses, pipes, and connections 600, 700, 800. If the amplitude (value) of the output pressure P2 is negligible (i.e. the value of P2 is so low that the PWM output variation is within acceptable limits) then this measurement can be left out of the regulation by setting the value of P2 to 0 atm (or 1 atm if absolute pressure value measurements are used), or if the variations of value of P2 are within acceptable limits, then the measurement of P2 can be replaced by a fixed value in the formula. An example is that if the output pressure P2 is measured to be e.g. 1.2bar, then the formula could be $\Delta P = P1 - 1.2$. The advantages are to reduce the number of measurements points, which again reduce the product price and complexity.

[0021] A difference in gas pressure $\Delta P = P1 - P2$ between the input 120 and output 140 of the valve, obtained as a pressure difference value by subtracting in a subtractor 131 the output pressure measurement 160 from the input pressure measurement 150, is fed to a pressure difference input 132 of the valve controller arrangement 133, and used therein to calculate the gas flow through the valve 110 when the valve is open.

[0022] The regulation of the gas flow can be done according to different methods in the valve controller arrangement 133 such as:

- a) look-up table for the required pulse width
- b) a function formula, polynomial that calculate the pulse width
- c) electronic hardware

resulting in an improved flow regulation shown in Fig. 9, which show a dramatically improvement of the flow control compared to the unregulated flow shown in Fig. 8.

[0023] In the following, an embodiment of the invention involving the use of one or more look-up tables to determine the valve control signal will be explained with reference to fig. 7.

[0024] The embodiment on the invention that employs look up tables, a set of values have been collected in previous measurements done for the actual fluids and components to be used. To collect the values for the ta-

bles, for different pressure levels of P1 and P2, the flow is measured and the resulting values are placed inside several look-up tables. The functionality of block 134, represents the process parameter Y and/ or user input X is user / process specific, and $\Delta P = P1 - P2$.

The value of ΔP points to the table that must be used, and the process parameter (Y) and/or user input, (X) are used to select within the table the PWM output value (170). For a typical welding application ΔP will vary between 1-6 bar, and for plasma-cutting applications the ΔP may be up to 12 bar. The number of tables to be used will vary with the requirements for accuracy, but can typically be one table pr. 0.5 - 1 bar. It can be sufficient to use fewer tables by introducing an interpolation method between the tables, which by calculation will give PWM outputs for values of ΔP that lies inbetween the values in the available tables.

[0025] In the following, an embodiment of the invention involving the use of Calculation to determine the valve control signal will be explained with reference to Fig 5.

[0026] The total block of 130 in Fig. 3 can be replaced by a calculation performed in a processor by way of suitable software. With reference to Fig. 5, a fluid passing through the orifice constriction represented by the valve's opening diameter D_o , will experience a drop in pressure across this orifice. This pressure drop is used to measure the flow rate of the fluid when the valve is in its open stage. The calculation of the flow rate of gas passing through the orifice of the valve is typically based on Bernoulli's equation, combined with the ON-period (T_{on}) relative to a total switching period T as described in Fig. 6. Bernoulli's equation can be modified to ease the calculation in a computer, and can by introducing a flow coefficient $C(f)$, be written as:

$$Q(\max) = C(f) \cdot A_o \cdot \sqrt{2 \cdot \Delta P / \rho}$$

where

- $Q(\max)$ = maximum volumetric flow rate (valve constant open)
- A_o = $\pi \cdot (D_o/2)^2$ = area of valve opening (in open stage)
- ΔP = $P1 - P2$
- ρ = Fluid density

[0027] The flow coefficient $C(f)$ is by experiment or in a datasheet for the actual orifice of the valve. In place of basing the determination of $Q(\max)$ and A_o on the physical characteristics of the valve itself, a separate orifice device may suitably be located directly at the gas input or gas output of the valve in such a way that the separate orifice device is the dominating element with regard to establishing $Q(\max)$ and A_o properties of the valve assembly.

[0028] Based on the required flow level Q for the par-

ticular application, which would correspond to the desired gas flow, the ON-period (Ton) for the PWM modulated valve is be calculated by:

$$Q = Q(\max) * T(\text{on}) / T$$

$$T(\text{on}) = T * Q / Q(\max)$$

[0029] The puls rate of the PWM output (170) are chosen based on the flow requirements for the application. The pulsation of the gas supplied at the outlet (1100) as a blanket gas in a welding application or as a blanket and/or cutting gas in a plasma cutting machine, as a result of the chosen pulse rate, must be within acceptable limits. I.e. it must not be variations in the supply of the gas at the outlet 1100 that will affect the quality of the welding or the cutting processes.

[0030] In addition the application specific parameters X (300) and Y (400) can be included in the calculation based on user specific settings X and / or process feedback parameter(s) Y.

[0031] In the following, an embodiment of the invention involving the use of hardware regulation to determine the valve control signal will be explained with reference to fig 3 and 4.

[0032] In a hardware solution, the ΔP (132) signal is fed into the block 133, and compared with an output signal from the a ramp generator 134. The magnitude of the output signal from the a ramp generator 134 is influenced by application specific parameters X and/or Y The ramp generator can be realized by a discrete hardware solution or by an timer circuit like the 555 timer circuit. The amplitude and/or the offset of the ramped output signal from the ramp generator 134 will be influenced by X and/ or Y either as a offset value or as a gain. This is normally user specific settings, but the resulting effect will be that a higher current 900, resulting in a higher value of the process specific feedback value Y, will require a higher level of gas flow. The influence of the user specific value X is that different welding or cutting operations will require different levels of gas flow. The parameters that will influence on the users setting of the X value is typical the material that is going to be welded or cut, the thickness of the material, the speed of the welding or cutting and the gas type used. The functionality of block 134, representing the process parameter Y and/ or user input X is user / process specific, with the result of a ramped output voltage. When the ramp voltage at the negative input of 137 is lower than ΔP , then the PWM output 170 is high (OFF). When the ramp voltage is higher than ΔP then the output is low (ON).

Gas leak detection:

[0033] Gas leak detection of the gas flow line from the

valve 110 of the flow controller of the invention to the output valve 800 of the welding apparatus. With both valves 110 and 800 closed, a constant pressure should normally be detected by the pressure sensor 140 at the output of the flow controller of the invention). If this pressure decreases with both valves 110 and 800 closed, this is useful as an indicator of a gas leak in the supply line between the valve of the flow controller of the invention and the output valve 800 of the welding apparatus.

Idle gas pressure maintenance:

[0034] Filling the gas flow line (600) with a minimum pressure to make a quick start of gas supply to the gas outlet (1100) when starting a new welding or cutting operation. This is typically valid in situations where the current 900 is off and the valve 800 is closed. When a new welding or cutting operation is started, then the gas should be available at the gas outlet 1100 when the current 900 is starting. If not this can cause failure or poor quality on the operation to be performed.

Claims

1. A shielding gas flow controller (100) for an electric arc welding apparatus for insertion into a shielding gas supply line between a shielding gas source (200) and a shielding gas valve (800) of the electric arc welding apparatus, the flow controller having a shielding gas (200) input and a shielding gas output (600), a controllable gas valve (110) connected between the shielding gas in- and outputs and having a control input (170), and a controller means having a first input (400) for receiving a welding signal representing an electrical welding arc current (900) of the welding apparatus during a welding operation and a gas flow setting control (300) means adapted to generate a flow setting output being function of the welding signal and representing a desired shielding gas flow, wherein the shielding gas flow controller further comprises an output pressure sensor (140) connected to the shielding gas output and arranged to provide a shielding gas output pressure measurement to a third controller means input (160), and a means adapted to determine a time at which the welding operation is not being performed on basis of the welding signal, **characterized in that** the shielding gas flow controller further comprises an input pressure sensor connected to the shielding gas input and arranged to provide a shielding gas input pressure measurement to a second controller means input, a flow setting output modifying means adapted to modify the flow setting output of the gas flow setting control means based on the shielding gas input and output pressure measurements, the welding signal, and

a characteristic of the controllable valve into a control signal (170) for input to the control input of the controllable gas valve so as to maintain during the welding operation a substantially constant shielding gas flow in the shielding gas supply line to the welding apparatus corresponding to the flow setting output substantially independent of actual shielding gas input and output pressures at the shielding gas in- and outputs, respectively, and **in that** the controller means is adapted to output to the controllable gas valve an idle control signal so as to maintain the output pressure (600) at a predetermined idle pressure level during the time at which the welding operation is not being performed.

2. The shielding gas flow controller of claim 1, comprising a gas leak detector means adapted to be enabled during a period in which the welding operation is not being performed determined on basis of the welding signal, the gas leak detector means including a subtractor means arranged to subtract the shielding gas output pressure measurement from the shielding gas input pressure measurement and to provide a pressure difference value output, and a pressure difference comparator having a comparator output and arranged to receive on first and second comparator inputs the pressure difference value output and a predetermined pressure difference reference value, respectively, and a comparator output providing a leak indication when the pressure difference value is substantially at or greater than the predetermined pressure difference reference value.
3. The shielding gas flow controller of claim 1, comprising a gas leak detector means adapted to be enabled during a period in which the welding operation is not being performed determined on basis of the welding signal (400), the gas leak detector means including a reference value to be the predetermined idle pressure level of claim 2, the measured output pressure level being continuously compared with the reference value, and a comparator output providing a leak indication when the pressure difference value change is substantially at or greater than the predetermined pressure difference reference value for a given period of time, whereby the section (600) of the gas flow line is checked by this gas leak checking method.
4. The shielding gas flow controller of claim 1 or 2, further comprising a pressure level detector receiving the shielding gas input pressure measurement and being adapted to effect provisioning of a valve closing signal to the controllable gas valve so as to close the gas valve when the shielding gas input pressure measurement indicates a gas pressure being at or less than a predetermined shielding gas input pressure minimum level.

5. The shielding gas flow controller of claim 1 or 2, further comprising a gas leak detection means for detecting a gas leak in the gas flow line (600), (700) and (800) adapted to measure the gas output pressure at the output (140) of the valve (110) during an welding operation, and adapted to indicate a leak in the gas flow line if the measured gas output pressure drops below a predetermined gas output pressure threshold.

Patentansprüche

1. Schutzgas-Durchflussregler (100) für ein Gerät zum elektrischen Lichtbogenschweißen zum Einsetzen in eine Schutzgaszuleitung zwischen eine Schutzgasquelle (200) und ein Schutzgasventil (800) des Gerätes zum elektrischen Lichtbogenschweißen, wobei der Durchflussregler aufweist:

einen Eingang für Schutzgas (200) und einen Schutzgasausgang (600),
ein regelbares Gasventil (110), das zwischen den Schutzgaseingang und -ausgang geschaltet ist und einen Regeleingang (170) aufweist, und
eine Reglereinrichtung (400), die einen ersten Eingang zum Empfangen eines Schweißsignals, das einen elektrischen Lichtbogenstrom (900) des Schweißgeräts während eines Schweißvorgangs repräsentiert, und eine Einrichtung zur Gasdurchfluss-Einstellungsregelung (300) aufweist, die dafür geeignet ist, eine Durchflusseinstellungsausgabe zu erzeugen, die eine Funktion des Schweißsignals ist und einen gewünschten Schutzgasdurchfluss repräsentiert,

wobei der Schutzgas-Durchflussregler ferner umfasst:

einen Ausgangsdrucksensor (140), der mit dem Schutzgasausgang verbunden und derart eingerichtet ist, dass er eine Schutzgas-Ausgangsdruckmessung für einen dritten Reglereinrichtungseingang (160) bereitstellt, und eine Einrichtung, die dafür geeignet ist, auf Grundlage des Schweißsignals eine Zeit zu ermitteln, zu der der Schweißvorgang nicht durchgeführt wird,

dadurch gekennzeichnet, dass der Schutzgas-Durchflussregler ferner einen Eingangsdrucksensor umfasst, der mit dem Schutzgaseingang verbunden und derart eingerichtet ist, dass er eine Schutzgas-Eingangsdruckmessung für einen zweiten Reglereinrichtungseingang bereitstellt,
eine Durchflusseinstellungsausgabe-Modifika-

- tionseinrichtung, die dafür geeignet ist, die Durchflusseinstellungsausgabe der Gasdurchflusseinstellungs-Regeleinrichtung auf Grundlage der Schutzgaseingangs- und -ausgangsdruckmessungen, des Schweißsignals und einer Charakteristik des regelbaren Ventils in ein Regelsignal (170) zum Eingeben in den Regeleingang des regelbaren Gasventils zu modifizieren, um während des Schweißvorgangs einen im Wesentlichen konstanten Schutzgasdurchfluss, entsprechend der Durchflusseinstellungsausgabe, im Wesentlichen jeweils unabhängig von tatsächlichen Schutzgas-Eingangsrücken und -ausgangsrücken an den Schutzgaseingängen und -ausgängen, in der Schutzgaszuleitung zu dem Schweißgerät aufrechtzuerhalten, und dass die Reglereinrichtung dafür geeignet ist, an das regelbare Gasventil ein Leerlaufregelsignal auszugeben, um den Ausgangsdruck (600) während der Zeit, zu der der Schweißvorgang nicht ausgeführt wird, auf einem vorgegebenen Leerlaufdruckniveau zu halten.
2. Schutzgas-Durchflussregler nach Anspruch 1, der eine Gasleck-Detektoreinrichtung umfasst, die dafür geeignet ist, während einer Zeitspanne aktiviert zu sein, in der der Schweißvorgang nicht durchgeführt wird, ermittelt auf Grundlage des Schweißsignals, wobei die Gasleck-Detektoreinrichtung eine Subtrahiereinrichtung, die dafür eingerichtet ist, die Schutzgasausgangsdruckmessung von der Schutzgaseingangsdruckmessung zu subtrahieren und eine Druckdifferenzwertausgabe bereitzustellen, und einen Druckdifferenzkomparator, der einen Komparatorausgang aufweist und derart eingerichtet ist, dass er an einem ersten und zweiten Komparator-eingang jeweils die Druckdifferenzwertausgabe und einen vorgegebenen Druckdifferenz-Referenzwert empfängt, und einen Komparatorausgang aufweist, der eine Leckanzeige bereitstellt, wenn der Druckdifferenzwert im Wesentlichen auf dem vorgegebenen Druckdifferenz-Referenzwert oder größer als dieser ist.
3. Schutzgas-Durchflussregler nach Anspruch 1, der eine Gasleck-Detektoreinrichtung umfasst, die dafür geeignet ist, während einer Zeitspanne aktiviert zu sein, in der der Schweißvorgang nicht durchgeführt wird, ermittelt auf Grundlage des Schweißsignals (400), wobei die Gasleck-Detektoreinrichtung einen Referenzwert, der das vorgegebene Leerlaufdruckniveau nach Anspruch 2 sein soll, wobei das gemessene Ausgangsdruckniveau kontinuierlich mit dem Referenzwert verglichen wird, und eine Komparatorausgabe aufweist, durch die eine Leckanzeige bereitgestellt wird, wenn die Druckdifferenzwertänderung im Wesentlichen auf dem vorgegebenen

Druckdifferenz-Referenzwert für eine gegebene Zeitspanne oder größer als dieser ist, wobei der Abschnitt (600) der Gasdurchflussleitung mithilfe dieses Gasleck-Prüfverfahrens überprüft wird.

4. Schutzgas-Durchflussregler nach Anspruch 1 oder 2, der ferner einen Druckniveaudetektor umfasst, der die Schutzgas-Eingangsdruckmessung empfängt und dafür geeignet ist, ein Bereitstellen eines Ventilschließsignals an das regelbare Gasventil zu bewirken, um das Gasventil zu schließen, wenn die Schutzgas-Eingangsdruckmessung anzeigt, dass ein Gasdruck auf einem vorgegebenen Schutzgas-Eingangsdruck-Minimalniveau oder geringer ist.
5. Schutzgas-Durchflussregler nach Anspruch 1 oder 2, der ferner eine Gasleck-Erkennungseinrichtung zum Erkennen eines Gaslecks in der Gasdurchflussleitung (600), (700) und (800) umfasst, die dafür geeignet ist, den Gasausgangsdruck an dem Ausgang (140) des Ventils (110) während eines Schweißvorgangs zu messen, und dafür geeignet ist, ein Leck in der Gasdurchflussleitung anzuzeigen, wenn der gemessene Gasausgangsdruck unter einen vorgegebenen Gasausgangsdruck-Schwellenwert abfällt.

Revendications

1. Régulateur de débit de gaz de protection (100) pour un appareil de soudage à l'arc électrique à insérer dans une ligne d'alimentation de gaz de protection entre une source de gaz de protection (200) et une soupape de gaz de protection (800) de l'appareil de soudage à l'arc électrique, le régulateur de débit comprenant une entrée de gaz de protection (200) et une sortie de gaz de protection (600), une soupape de gaz contrôlable (110) connectée entre les entrée et sortie de gaz de protection et présentant une entrée de commande (170), et des moyens de commande présentant une première entrée (400) pour recevoir un signal de soudage représentant un courant d'arc de soudage électrique (900) de l'appareil de soudage pendant une opération de soudage et des moyens de commande de réglage de débit de gaz (300) aptes à générer une sortie de réglage de débit en fonction du signal de soudage et qui représente un débit de gaz de protection souhaité, dans lequel le régulateur de débit de gaz de protection comprend en outre un capteur de pression de sortie (140) qui est connecté à la sortie de gaz de protection et qui est agencé de manière à fournir une mesure de pression de sorte de gaz de protection à une troisième entrée de moyen de commande (160), et des moyens aptes à déterminer un moment auquel l'opération de soudage n'est pas exécutée sur la base du signal de soudage,

- caractérisé en ce que** le régulateur de débit de gaz de protection comprend en outre un capteur de pression d'entrée qui est connecté à l'entrée de gaz de protection et qui est agencé de manière à fournir une mesure de pression d'entrée de gaz de protection à une deuxième entrée de moyen de commande, des moyens de modification de sortie de réglage de débit aptes à modifier la sortie de réglage de débit des moyens de commande de réglage de débit de gaz sur la base des mesures de pression d'entrée et de sortie de gaz de protection, du signal de soudage et d'une caractéristique de la soupape contrôlable en un signal de commande (170) à entrer dans l'entrée de commande de la soupape de gaz contrôlable de manière à maintenir pendant l'opération de soudage un débit de gaz de protection sensiblement constant dans la ligne d'alimentation en gaz de protection à l'appareil de soudage qui correspond à la sortie de réglage de débit sensiblement indépendante des pressions d'entrée et de sortie de gaz de protection réelles aux entrées et sortie de gaz de protection, respectivement, et **en ce que** les moyens de commande sont aptes à communiquer à la soupape de gaz contrôlable un signal de commande à vide de manière à maintenir la pression de sortie (600) au niveau de pression à vide prédéterminé pendant la période pendant laquelle l'opération de soudage n'est pas exécutée.
2. Régulateur de débit de gaz de protection selon la revendication 1, comprenant des moyens de détecteur de fuite de gaz aptes à être activés pendant une période pendant laquelle l'opération de soudage n'est pas exécutée déterminée sur la base du signal de soudage, les moyens de détecteur de fuite de gaz comprenant des moyens de soustracteur agencés de manière à soustraire la mesure de pression de sortie de gaz de protection de la mesure de pression d'entrée de gaz de protection et à générer une sortie de valeur de différence de pression, et un comparateur de différence de pression présentant une sortie de comparateur et agencé de manière à recevoir sur des première et deuxième entrées de comparateur la sortie de valeur de différence de pression ainsi qu'une valeur de référence de différence de pression prédéterminée, respectivement, et une sortie de comparateur fournissant une indication de fuite lorsque la valeur de différence de pression est sensiblement égale ou supérieure à la valeur de référence de différence de pression prédéterminée.
 3. Régulateur de débit de gaz de protection selon la revendication 1, comprenant des moyens de détecteur de fuite de gaz aptes à être activés pendant une période pendant laquelle l'opération de soudage n'est pas exécutée déterminée sur la base du signal de soudage (400), les moyens de détecteur de fuite de gaz comprenant une valeur de référence devant correspondre au niveau de pression à vide prédéterminé de la revendication 2, le niveau de pression de sortie mesuré étant comparé de façon continue avec la valeur de référence, et une sortie de comparateur fournissant une indication de fuite lorsque la variation de la valeur de différence de pression est sensiblement égale ou supérieure à la valeur de référence de différence de pression prédéterminée pendant une période de temps donnée, moyennant quoi la section (600) de la ligne d'écoulement de gaz est contrôlée en appliquant ce procédé de vérification de fuite de gaz.
 4. Régulateur de débit de gaz de protection selon la revendication 1 ou 2, comprenant en outre un détecteur de niveau de pression qui reçoit la mesure de pression d'entrée de gaz de protection et qui est apte à assurer l'envoi d'un signal de fermeture de soupape à la soupape de gaz contrôlable de manière à fermer la soupape de gaz lorsque la mesure de pression d'entrée de gaz de protection indique qu'une pression de gaz est égale ou inférieure à un niveau minimum de pression d'entrée de gaz de protection prédéterminé.
 5. Régulateur de débit de gaz de protection selon la revendication 1 ou 2, comprenant en outre des moyens de détection de fuite de gaz pour détecter une fuite de gaz dans la ligne d'écoulement de gaz (600), (700) et (800) et aptes à mesurer la pression de sortie de gaz à la sortie (140) de la soupape (110) pendant une opération de soudage, et aptes à indiquer une fuite dans la ligne d'écoulement de gaz si la pression de sortie de gaz mesurée chute en dessous d'un seuil de pression de sortie de gaz prédéterminé.

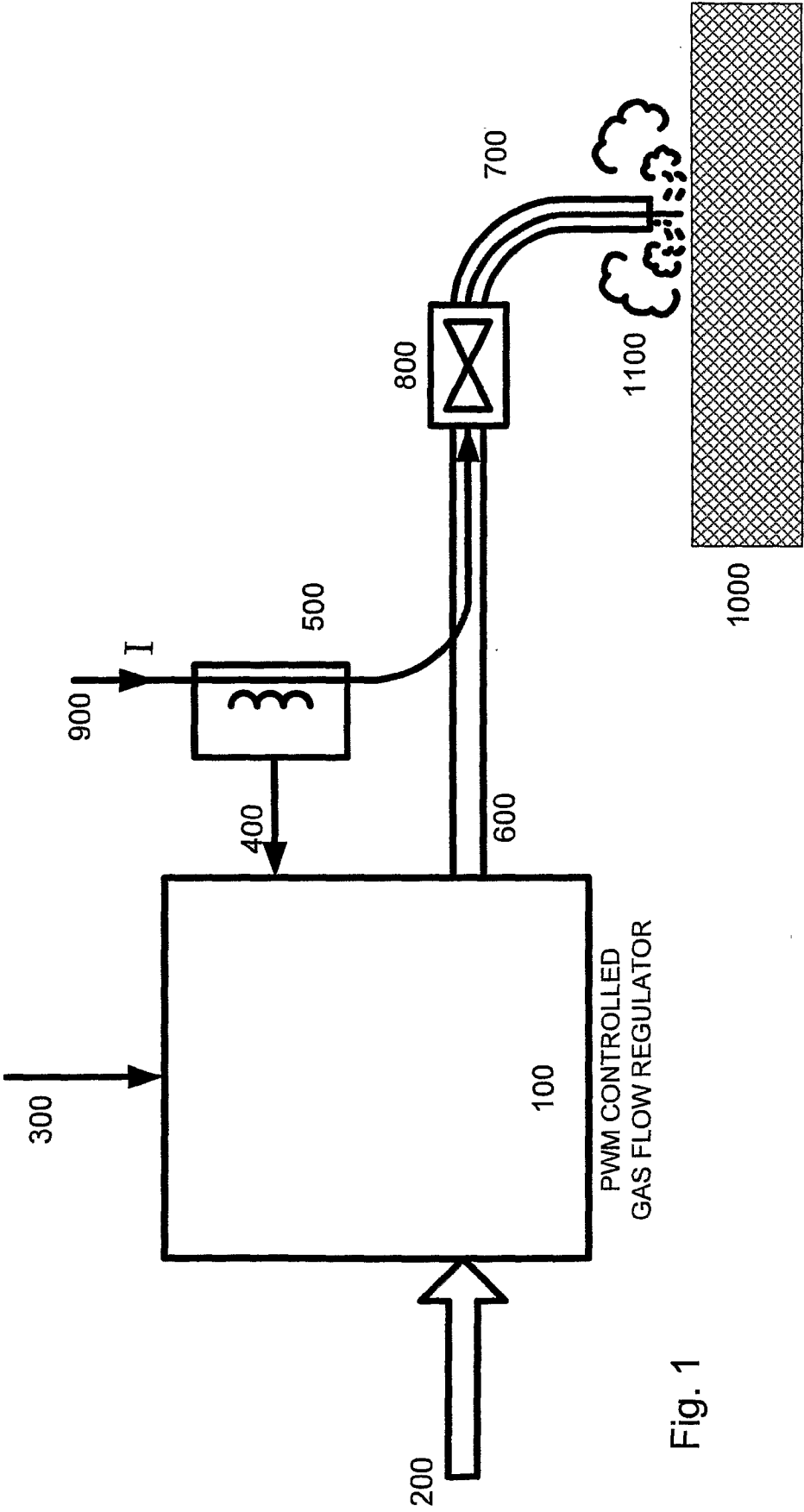
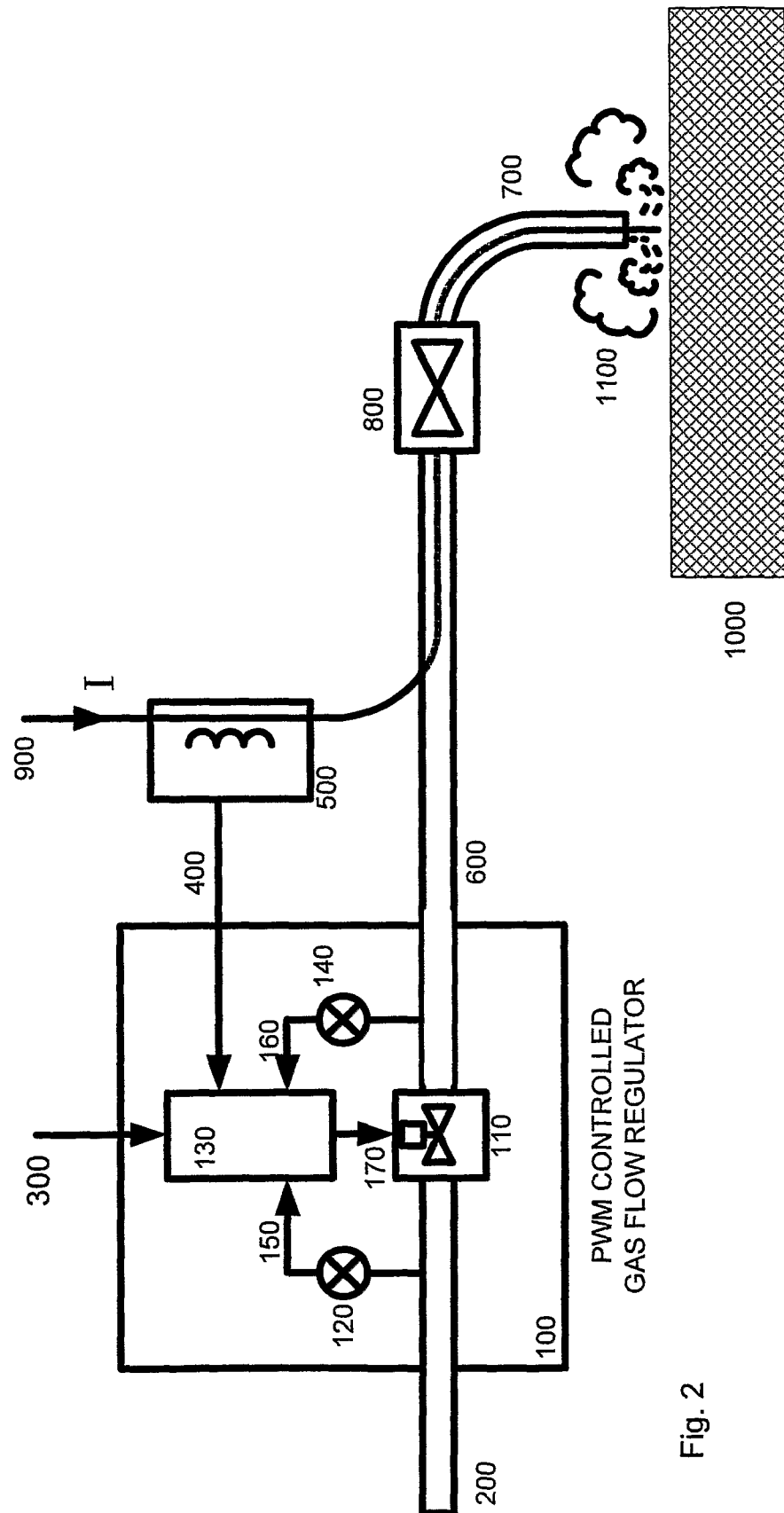
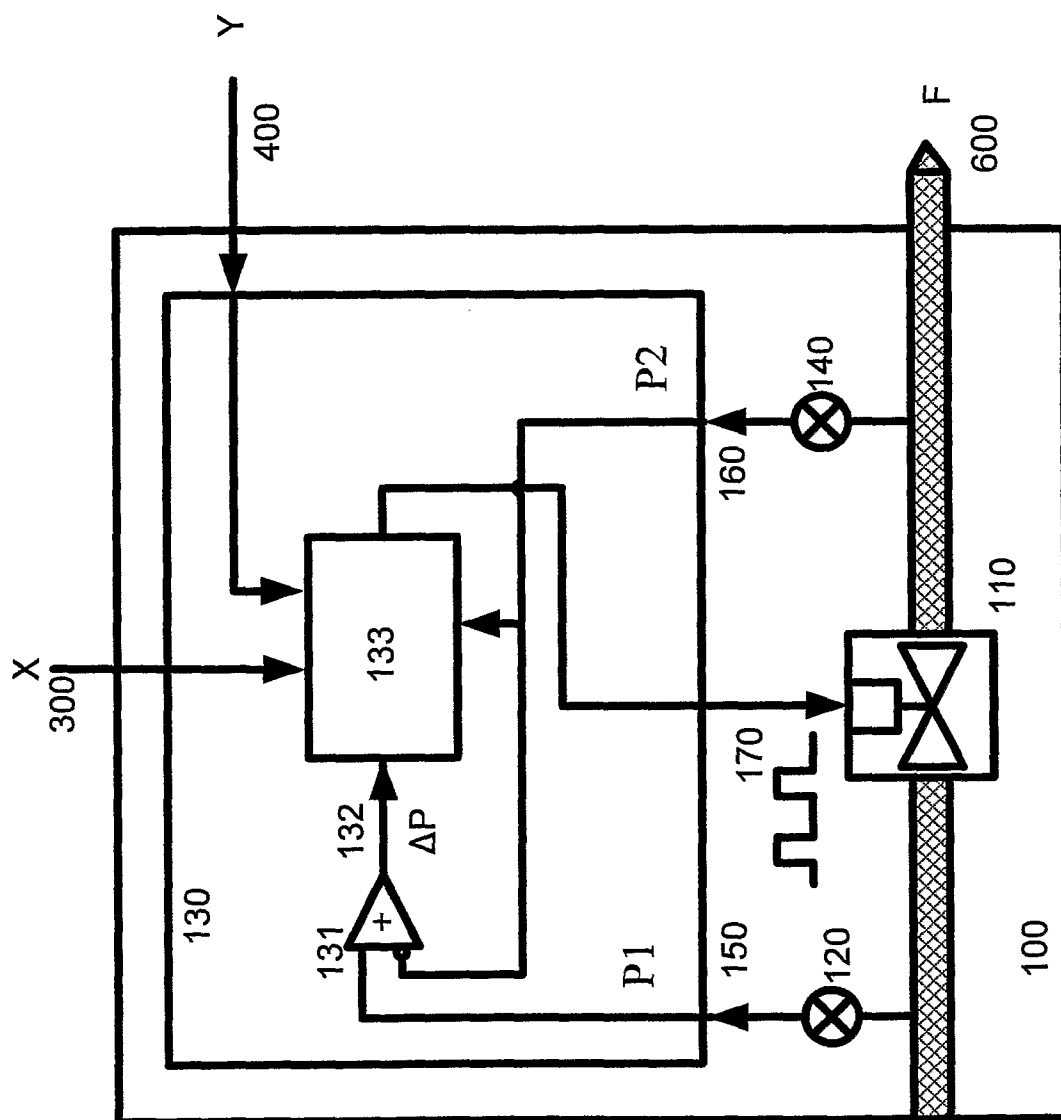


Fig. 1





PWM CONTROLLED
GAS FLOW REGULATOR

Fig. 3

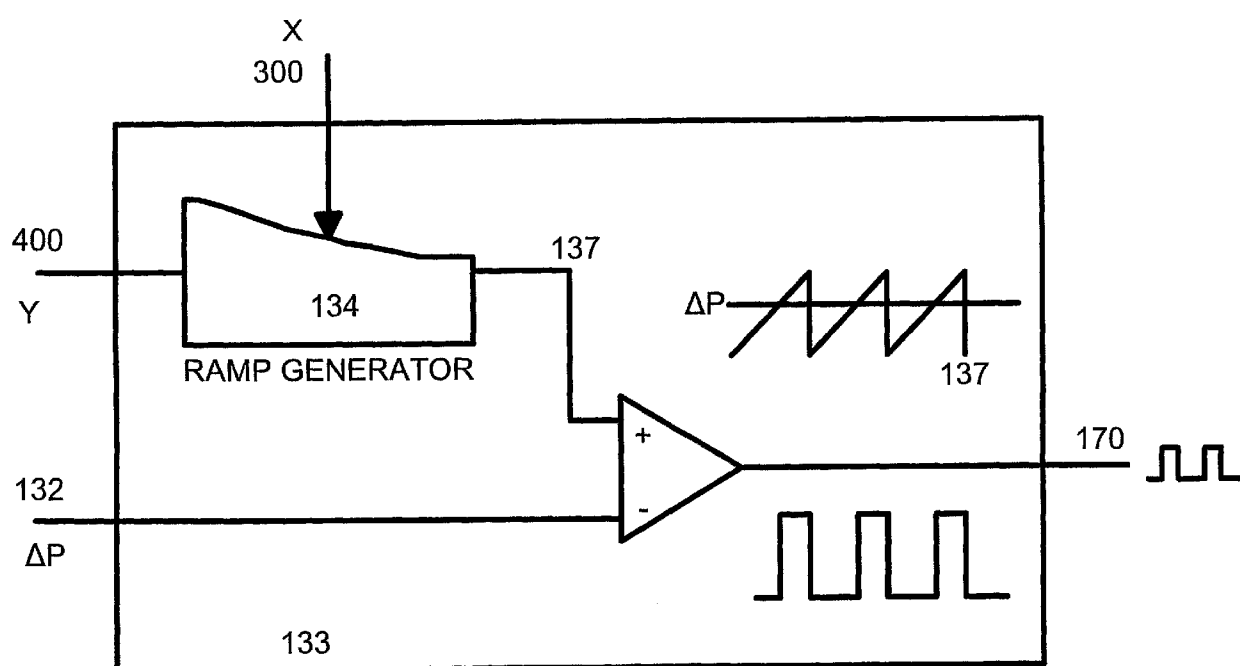


Fig. 4 Hardware Regulation

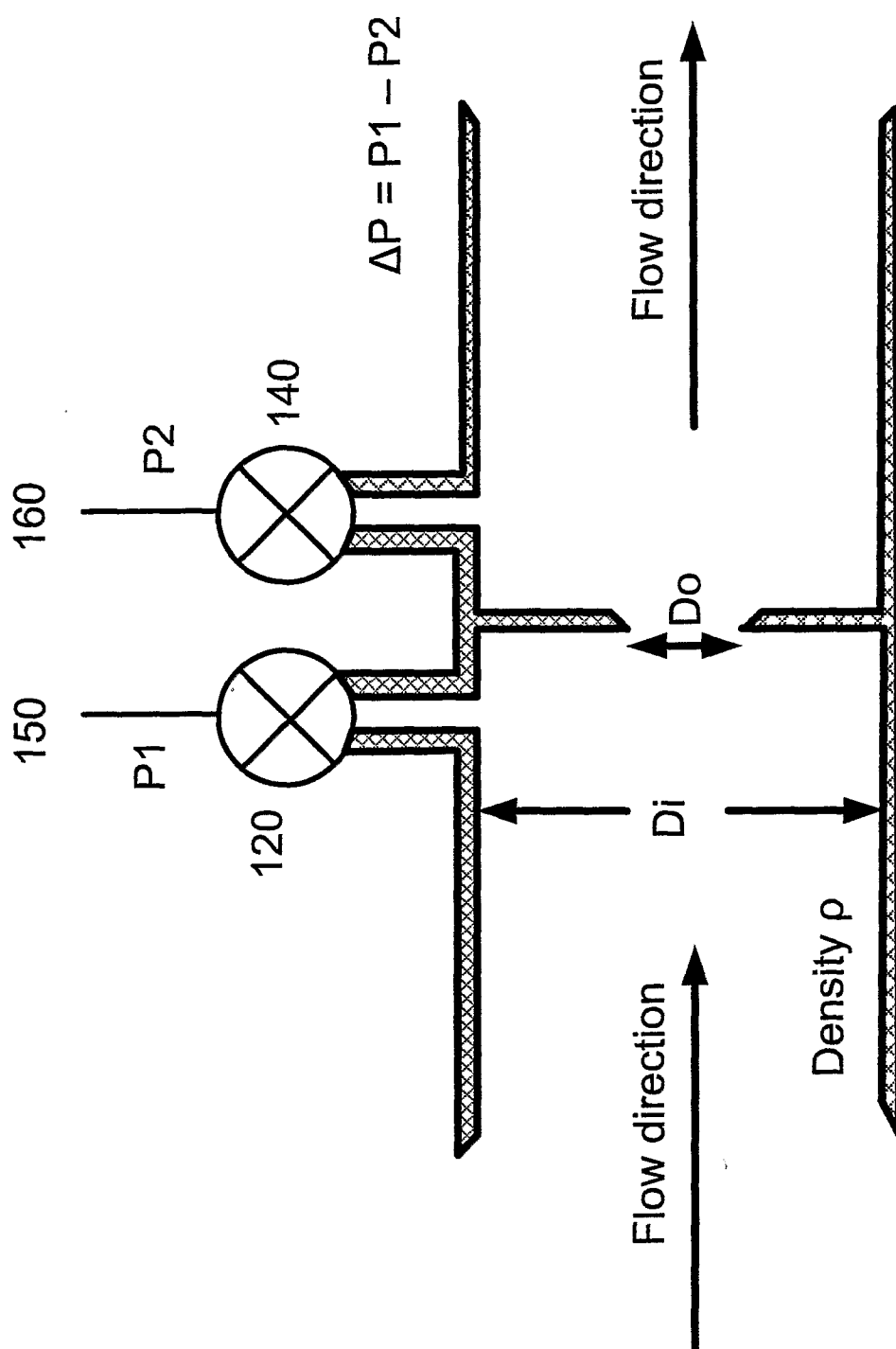


Fig. 5 Measurement of Gas Flow and Pressure

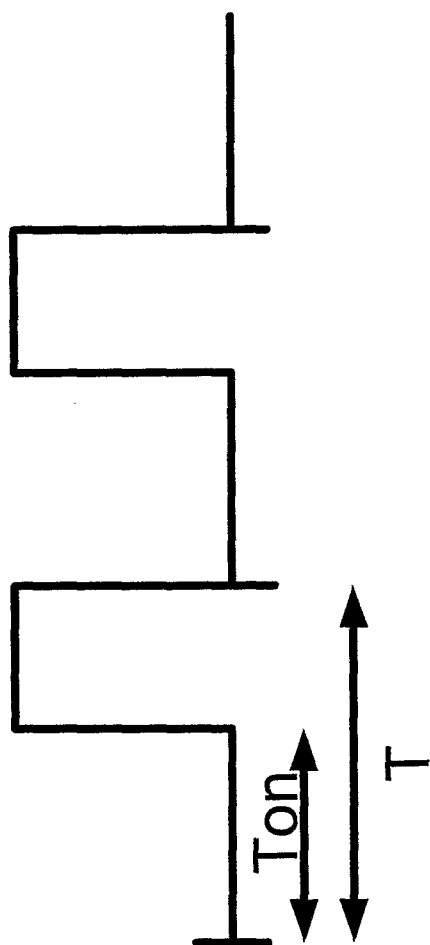


Fig. 6 PWM Control

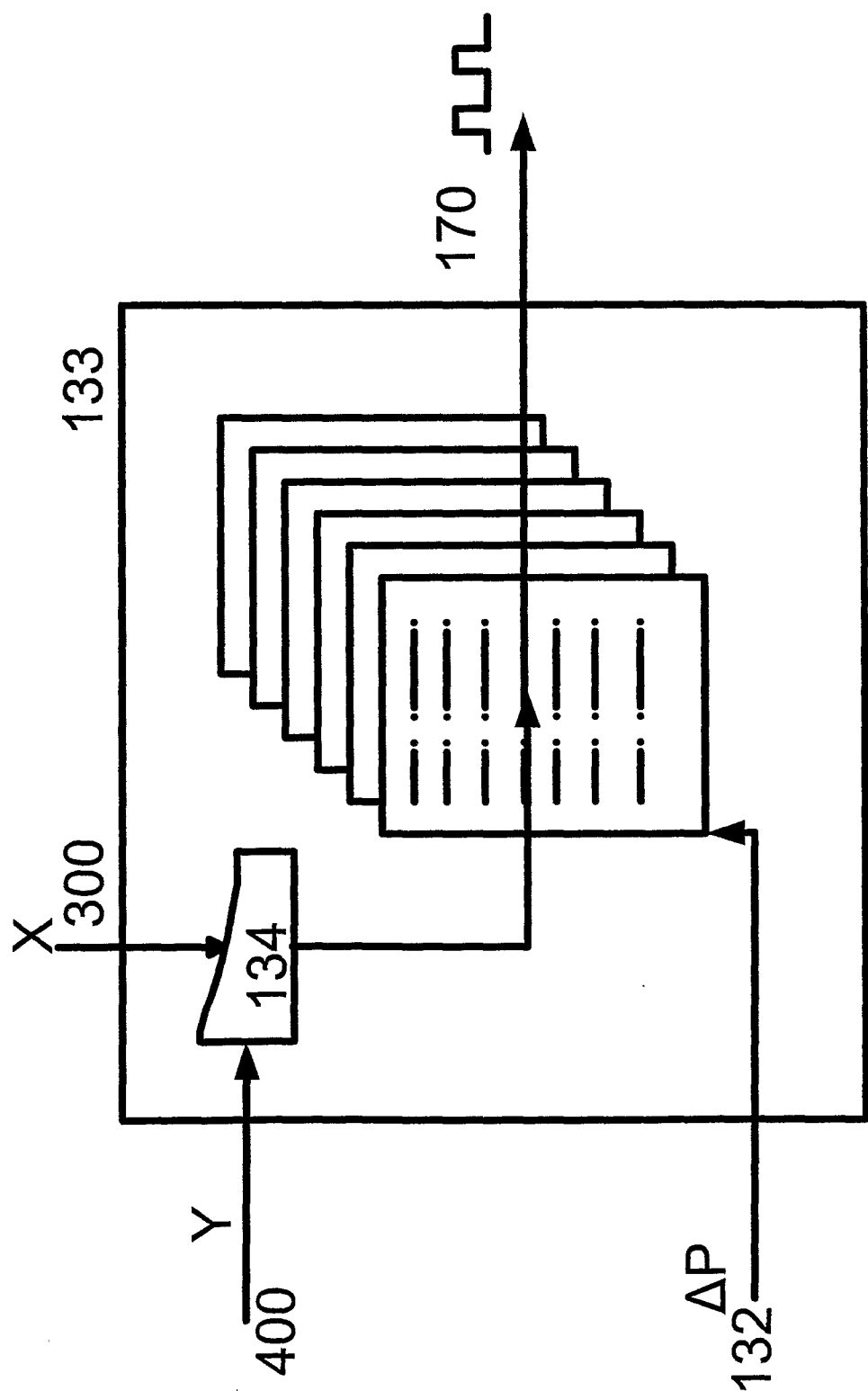


Fig. 7 Look Up Table regulation

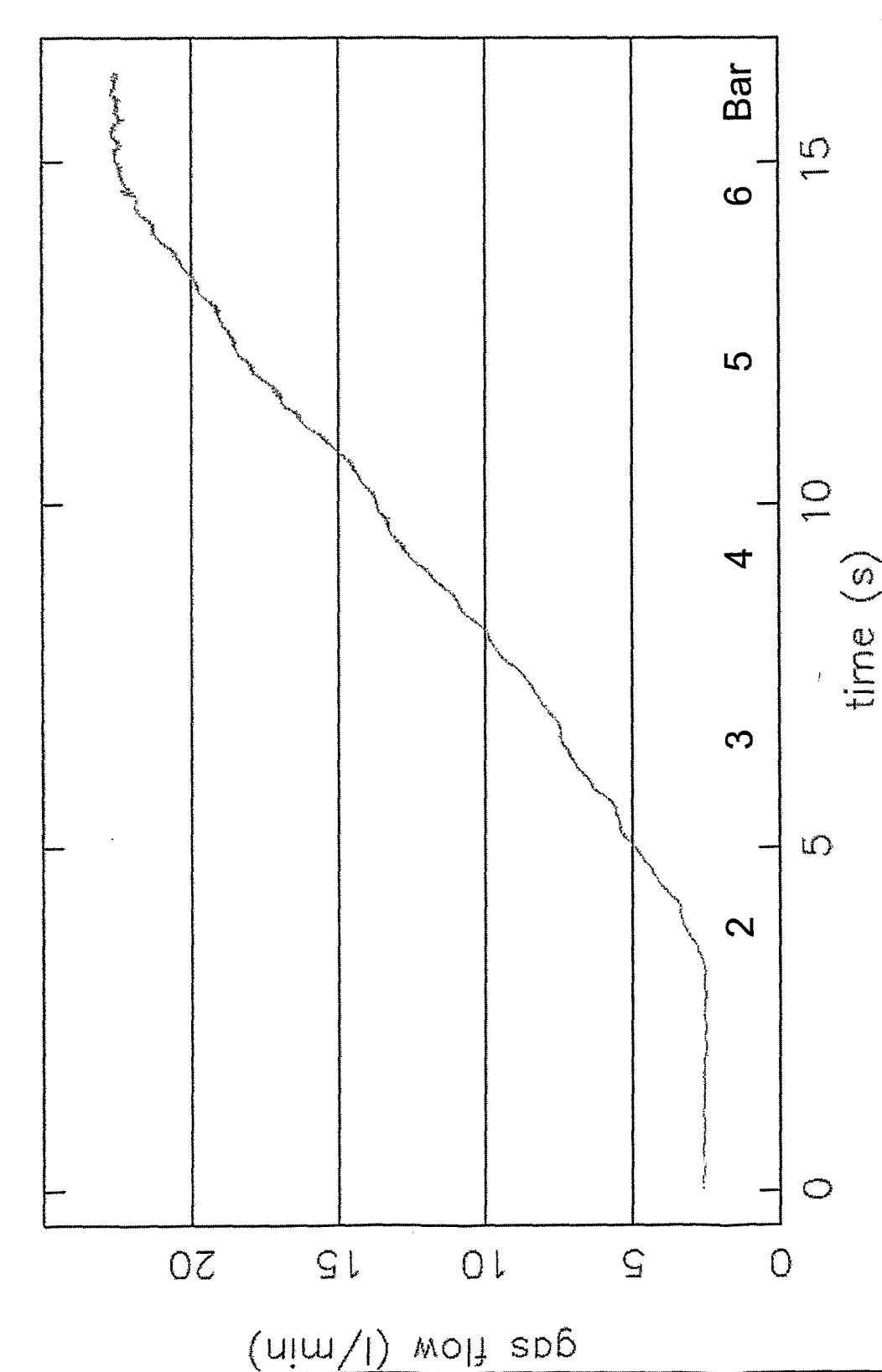


Fig. 8 Gas Flow through the valve 110 with no pressure regulation and a pressure rise from 2 to 6 bar

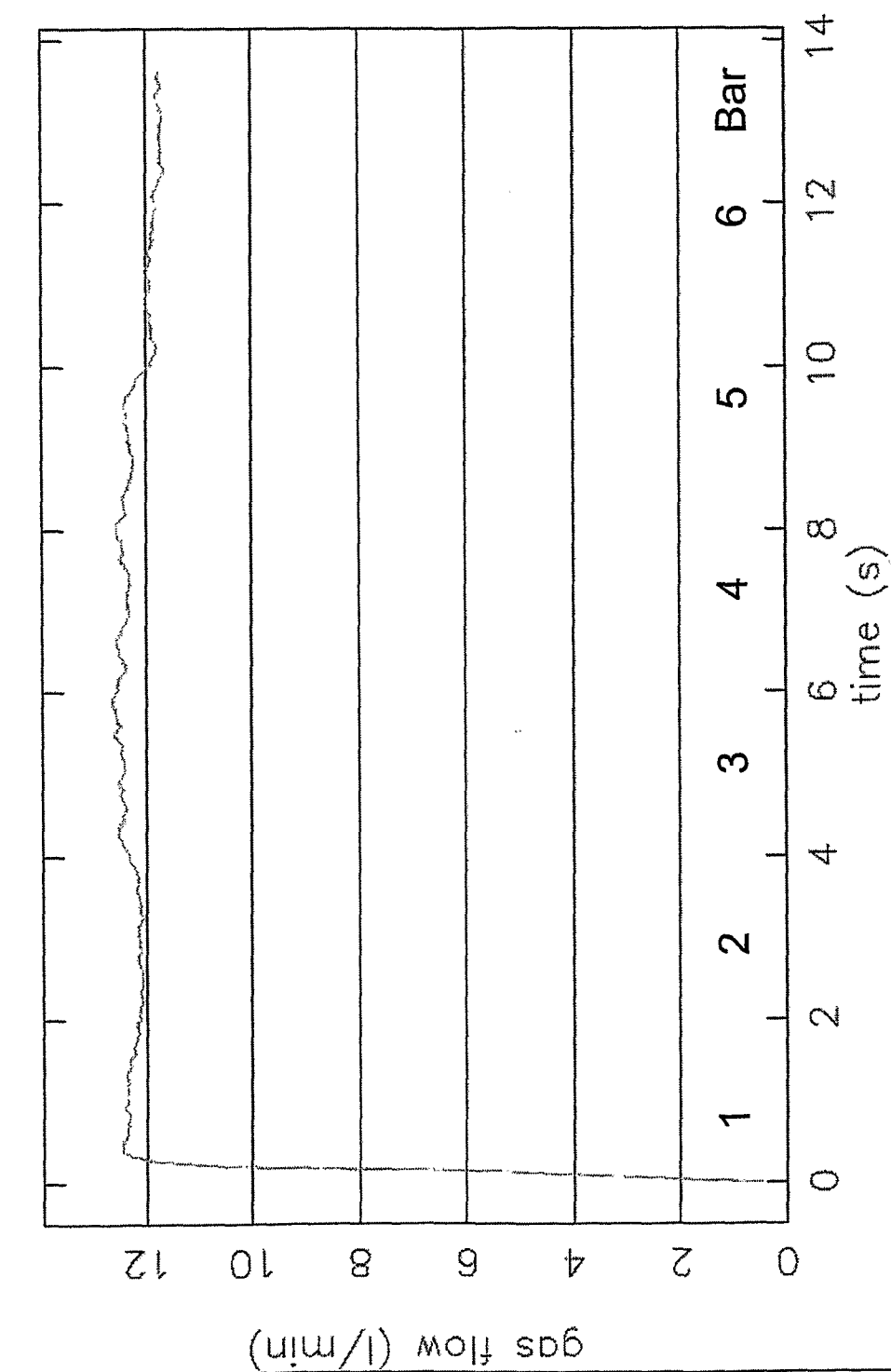


Fig. 9 Gas Flow through the valve 110 with pressure regulation and a pressure rise from 0 to 6 bar

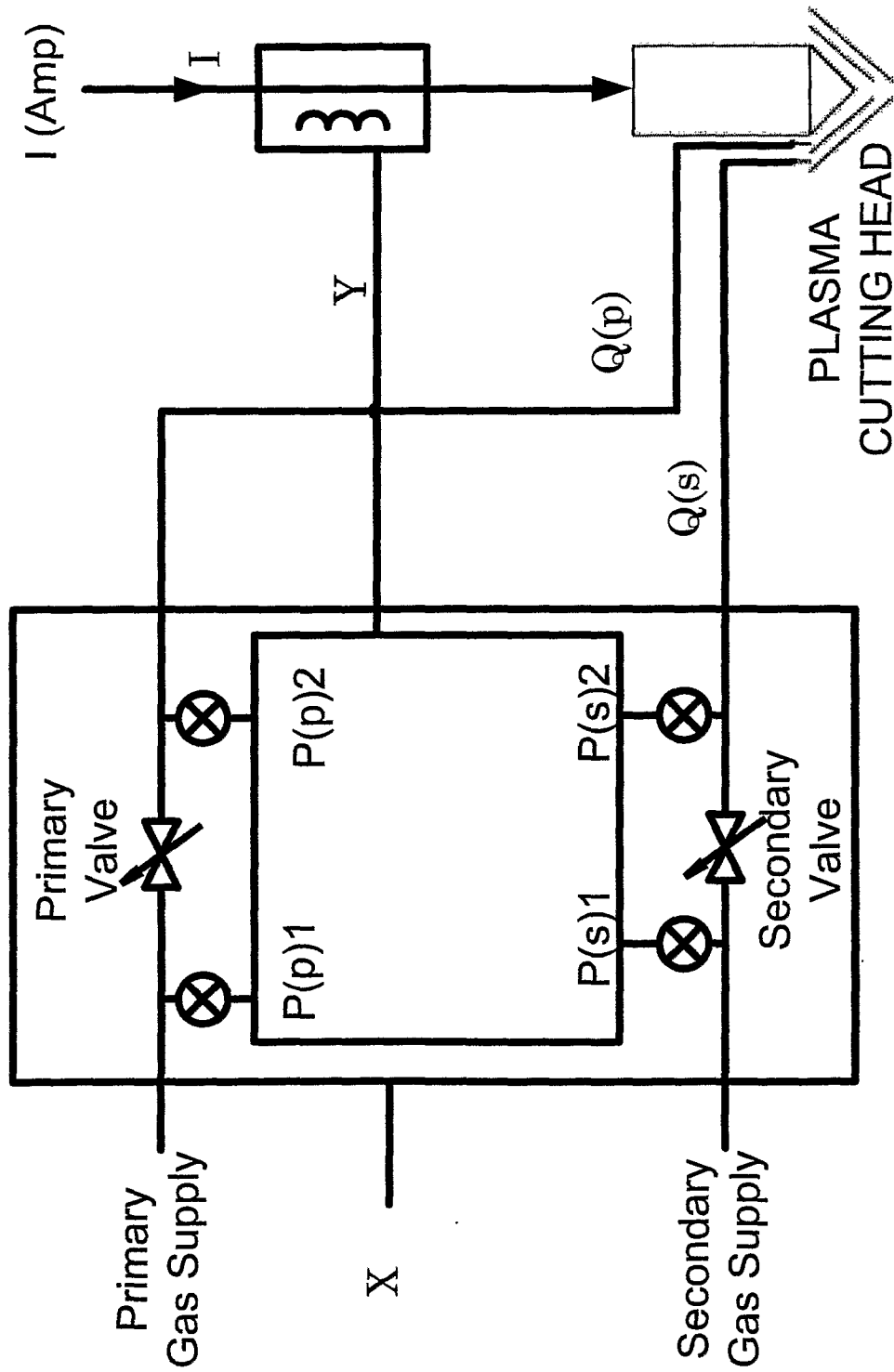


Fig. 10 Illustration of gas regulation of a Plasma cutting machine

REFERENCES CITED IN THE DESCRIPTION

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VÉDŐGÁZ ÁRAMLÁSSZABÁLYOZÓ HEGESZTŐKÉSZÜLÉKHEZ
SZABADALMI IGÉNYPONTOK

1. Védőgáz (shielding gas) áramlásszabályozó (flow controller) elektromos ívhegesztő berendezéshez (electric arc welding apparatus) beiktatásra egy védőgáz szolgáltató vonalba (shielding gas supply) az elektromos ívhegesztő berendezés védőgáz forrása (200) és védőgáz szelepe (valve) (800) közé; az áramlásszabályozó a következőkkel rendelkezik:

védőgáz bemenet (input) (200) és védőgáz kimenet (output) (600);

szabályozható gázszelep (110), amely összeköttetést biztosít a védőgáz be- és kimenetek között és rendelkezik egy szabályozó bemenettel (170); és

szabályozó eszköz (controller means), amelynek van egy első bemenete (400) egy hegesztési jel (welding signal) befogadására, amely jel képviseli a hegesztő berendezés elektromos hegesztő ív áramát (electrical welding arc current) (900) egy hegesztési művelet során, és van egy gázáramlás beállítás szabályozó eszköze (gas flow setting control means) (300), amely úgy van adaptálva, hogy generáljon egy áramlás beállító kimenetet (flow setting output), ahol ez a hegesztési jel függvénye és képviseli a kívánt védőgáz áramlást;

ahol a védőgáz áramlásszabályozó tartalmaz továbbá egy kimenő nyomás érzékelőt (output pressure sensor) (140), amely hozzá van kapcsolva (connect) a védőgáz kimenethez és úgy van elrendezve, hogy szolgáltatson egy védőgáz kimeneti nyomásmérést egy harmadik szabályozó eszköz bemenetéhez (160); és egy eszközt, amely úgy van adaptálva, hogy meghatározza azt az időt, amelynél hegesztési művelet nincs végrehajtva a hegesztési jel alapján, **azzal jellemezve, hogy** a védőgáz áramlásszabályozó tartalmaz továbbá egy bemeneti nyomásérzékelőt, amely hozzá van kapcsolva a védőgáz bemenethez és úgy van elrendezve, hogy szolgáltatson egy védőgáz bemeneti nyomásmérést egy második szabályozó eszköz bemenetéhez, tartalmaz továbbá egy áramlás beállító kimenet módosító eszközt (modifying means), amely úgy van adaptálva, hogy módosítsa a gázáramlás beállító szabályozó eszköz áramlás-beállító kimenetét a védőgáz bemeneti és kimeneti nyomásmérésekre, a hegesztési jelre és a szabályozható szelep jellemzőire alapozva egy szabályozó jelbe (control signal) (170) a bemenethez a szabályozható gázszelep szabályozó bemenetéhez (control input) úgy, hogy fennmaradjon a hegesztési művelet során egy lényegében állandó védőgáz áramlás a védőgáz szolgáltató vonalban a hegesztő berendezéshez, ahol ez megfelel az áramlás beállító kimenetnek és lényegében független az aktuális védőgáz bemeneti- és kimeneti nyomásoktól a védőgáz be- illetve kimeneteknél, továbbá **azzal jellemezve, hogy** a szabályozó eszközök (controller means) adaptálva vannak a kimenethez olyan módon, hogy kibocsássanak a szabályozható gázszelepekhez egy üresjárat (idle) szabályozó jelet úgy, hogy fennmaradjon a kimeneti nyomás (600) egy előre meghatározott üresjárat nyomásszinten azon időtartam során, amelynél hegesztési művelet nincs végrehajtva.

2. Az 1. igénypont szerinti védőgáz áramlásszabályozó, amely tartalmaz egy gázszivárgás-jelző eszközt (gas leak detector means), amely úgy van adaptálva, hogy annak az időtartamnak a során, amelyben hegesztési művelet nincs végrehajtva a hegesztési jel alapján meghatározva, is képes legyen működni; a gázszivárgás-jelző eszköz magában foglal egy kivonó eszközt (subtractor means), amely úgy van elrendezve, hogy kivonja a védőgáz kimeneti nyomásmérést a védőgáz bemeneti nyomásmérésből, és szolgáltatson egy nyomáskülönbség érték (pressure difference value) kimenetet, és magában foglal egy nyomáskülönbség összehasonlító (pressure difference comparator), amelynek van egy összehasonlító kimenete, és úgy van elrendezve, hogy befogadja az első és második összehasonlító bemeneteken a nyomáskülönbség érték kimenetet, illetve egy előre meghatározott nyomáskülönbség referencia értéket, és egy összehasonlító (comparator) kimenetet, amely szolgáltat egy szivárgás jelzést (leak indication), amikor a nyomáskülönbség értéke lényegében megfelel az előre meghatározott nyomáskülönbség referencia értéknek vagy annál nagyobb.

3. Az 1. igénypont szerinti védőgáz áramlásszabályozó, amely tartalmaz egy gázszivárgás-jelző eszközt (gas leak detector means), amely úgy van adaptálva, hogy annak az időtartamnak a során, amelyben hegesztési művelet nincs végrehajtva a hegesztési jel (400) alapján meghatározva, is képes legyen működni, a gázszivárgás-jelző eszköz magában foglal egy referencia értéket a 2. igénypont előre meghatározott üresjáratú (idle) nyomásszintjéhez; a mért kimeneti nyomásszint folyamatosan össze van hasonlítva a referencia értékkel, és egy összehasonlító kimenet szolgáltat egy szivárgásjelzést, amikor a nyomáskülönbség érték változás lényegében megfelel az előre meghatározott nyomáskülönbség értéknek vagy annál nagyobb egy adott időtartam során, ezáltal a gázáramlási vonalnak egy szakaszát (section) (600) ellenőrizzük ennek a gázszivárgást ellenőrző eljárásnak (gas leaking checking method) a segítségével.

4. Az 1. vagy 2. igénypont szerinti védőgáz áramlásszabályozó, amely tartalmaz továbbá egy nyomásszint kimutatót (pressure level detector), amely befogadja a védőgáz bemeneti nyomásmérést, és úgy van adaptálva, hogy hatással legyen egy szelepszáró jel szolgáltatására a szabályozható gázszelephez úgy, hogy zárja a gázszelepet, amikor a védőgáz bemeneti nyomásmérés olyan gáznyomást jelez, amely egy előre meghatározott védőgáz bemeneti nyomás minimális szintjénél van, vagy annál is kisebb.

5. Az 1. vagy 2. igénypont szerinti védőgáz áramlásszabályozó, amely tartalmaz továbbá egy gázszivárgást kimutató eszközt gázszivárgás kimutatására a gáz áramlási vonalban (600), (700) és (800) és úgy van adaptálva, hogy mérje a gáz kimeneti nyomást a szelep (110) kimeneténél (140) egy hegesztési művelet során, és úgy van adaptálva, hogy jelezzen szivárgást (leak) a gáz áramlási vonalban, ha a mért gáz kimeneti nyomás egy előre meghatározott gáz kimeneti nyomás küszöb alá esik.