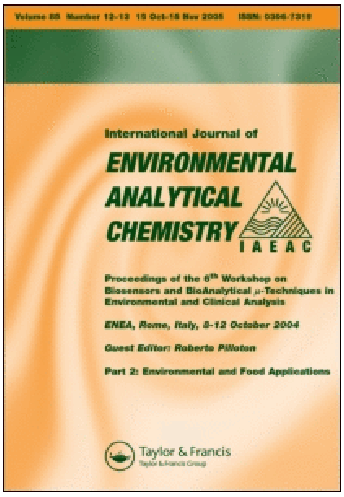

International Journal of Environmental Analytical Chemistry
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713640455

Automatic Gas Sample Pressure Controller

T. A. Gosink[a]; R. L. Seitz[a]
[a] Institute of Marine Science, University of Alaska, Fairbanks, Ak, U.S.A.

To cite this Article Gosink, T. A. and Seitz, R. L.(1979) 'Automatic Gas Sample Pressure Controller', International Journal of Environmental Analytical Chemistry, 6: 3, 263 — 266
To link to this Article: DOI: 10.1080/03067317908071179
URL: http://dx.doi.org/10.1080/03067317908071179

Intern. J. Environ. Anal. Chem., 1979, Vol. 6, pp. 263–266

Automatic Gas Sample Pressure Controller

T. A. GOSINK and R. L. SEITZ

Institute of Marine Science, University of Alaska, Fairbanks Ak 99701 U.S.A.

(*Received September 6, 1978*)

A system of an absolute pressure transducer, as a part of a wheatstone bridge and amplifier, with a servo controlled valve, automatically controls the pressure in a gas sample loop. The precision of samples controlled by this method is about ±0.2%. The device is applicable to a number of analytical instruments such as gas chromatographs and infrared spectrometers, and should be suitable for aircraft use.

KEY WORDS: Pressure transducer, gas sampling, GC, IR.

One of the critical steps for accurate and precise measurement of gases is the control of the size of the sample used. Sample loops for many applications provide suitable precision. However, for long term repetitive samplings, or systems sampling different sources, pumps, flow rates etc., additional controls, if not more frequent standard samples, are required. We have developed a system for gas chromatography which maintains the absolute pressure in the sample loop to about ±0.2% of the set point. The sample loop is mounted inside the analytical oven where the temperature is controlled to better than 0.1°C, therefore sample size is constant (±0.03%) with respect to temperature. Calibration of the sample loop and valve volume has been described by Cuddeback *et al.*[1]

The flow scheme for the system is shown in Figure 1. This particular system time multiplexes four different sample sources and standard(s). The gases can be vented as shown for simplicity, or valved back to a closed system. Coarse valves after the pumps are necessary to reduce the pressure to the range of the transducer and fine metering valve which is about ±40 mm Hg from the set point. The pressure sensor is the Unimeasure® Model P2 which is a relatively inexpensive piezo-resistive device with a resistance-pressure relationship of $\Omega \simeq 138.4 + 0.205\, P_{\text{mm}}$ Hg (absolute), and is good up to about 1000 mm Hg. Other models are available for higher pressures. The electronic system design (Figure 2) will allow for the

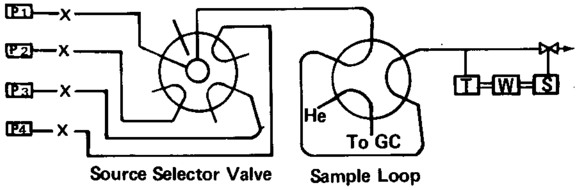

FIGURE 1 Flow schematic for four different sources being pressure controlled by Unimeasure® transducer (T), Wheatstone bridge amplifier (WA) and servo mechanism (S). P = pump, X = coarse control valve Whitney B-ORM2. Precision valve on servo = Nupro SS-2SGD.

detection of 0.1 mm Hg change in pressure. Whole system response, however, is slow enough so that the pressure control is coarser than this. The ten turn potentiometer is to control the point (or pressure) at which the wheatstone bridge will balance. Similar designs can be found in books on operational amplifiers such as Grame *et al.*[2]

The precision valve is closed by the stepper motor if the pressure in the sample loop is too low; opened if it is too high. In this work the Nupro SS-2SGD valve was chosen so as to operate in the ranges of 100–200 ml/min flow rate and 50–250 mm Hg pressure differential. Selection of a valve for other applications or control parameters requires the computation of the valve flow coefficient (C_v) which is usually provided by the manufacturer in engineering rather than metric terms.

$$C_v = \frac{Q}{\dfrac{16.05(P_1^2 - P_2^2)^{1/2}}{T^\circ}} \qquad \begin{aligned} &Q = \text{SCFM (ft}^3\text{/min)} \\ &P_1, P_2 = \text{PSIA} \\ &T = 450^\circ + {}^\circ\text{F} \end{aligned}$$

In the design of the mechanical linkage between the stepper motor and the vernier end of the precision valve, it is important to provide both a slip clutch to avoid jamming and to allow for the travel of the valve stem.

The control point can be measured on the Unimeasure® by switching it out of the system, and using a $4\frac{1}{2}$ digit (or better) digital ohmmeter.

In our work where the coarse valves bring the various sources roughly into line, and there is not too much drift over short periods of time, only a few pulses to the stepper motor are required to stabilize the system. The maximum pulse rate of the XR220 is determined by the resistor to pin 1 and the capacitor to pins 3 and 5 according to the formula $F = \frac{1}{2} R^{-1} C^{-1}$. Here $R = 10$ kohms and $C = 5\,\mu$f so that $F = 10$/sec. Ninety-six pulses are required for one full turn of the precision valve.

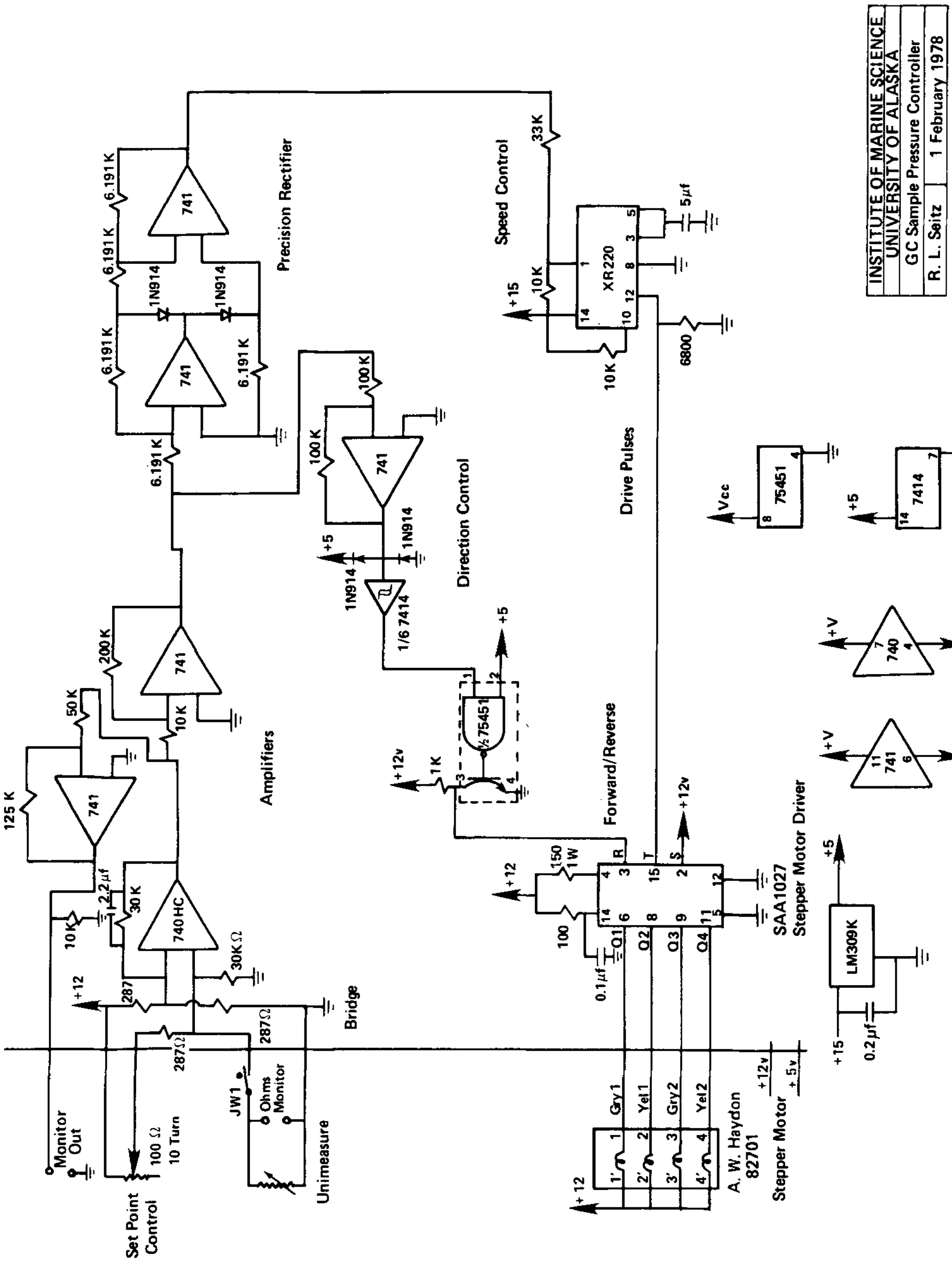

FIGURE 2 Electronic schematic for pressure control system.

The current cost of the Unimeasure®[3] electronic components and precision valve is approximately $900. The system should be applicable to other analytical procedures e.g., flow through infrared sample cells. Since the pressure is absolute, it should be adaptable to measurements made from aircraft where profound pressure changes will occur.

Acknowledgements

This work was supported by the Office of Naval Research, Contract N00014-76C-0331 at the Institute of Marine Science, University of Alaska, Fairbanks, 99701.

References

1. J. E. Cuddeback, S. R. Birch and W. R. Burg. *Anal. Chem.* **47,** 355 (1975).
2. J. D. Grame, G. E. Toby and L. P. Hvelsman, Operational Amplifiers, design and application. McGraw-Hill, 1971, pp. 208–212—Bridge Amplifiers.
3. Unimeasure is a product trade name, Available from Unimetrics Corp., 1853 Raymond Ave., Anaheim Calif. 92801.