



US006200819B1

(12) **United States Patent**
Harvey et al.

(10) **Patent No.:** US **6,200,819 B1**
(45) **Date of Patent:** ***Mar. 13, 2001**

(54) **METHOD AND APPARATUS FOR PROVIDING DILUENT GAS TO EXHAUST EMISSION ANALYZER**

(75) Inventors: **R. Neal Harvey**, Santa Ana; **Allen F. Dageforde**, Orange, both of CA (US)

(73) Assignee: **Horiba Instruments, Inc.**, Irvine, CA (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **08/606,242**

(22) Filed: **Feb. 23, 1996**

Related U.S. Application Data

(63) Continuation-in-part of application No. 08/536,401, filed on Sep. 29, 1995, now Pat. No. 5,756,360.

(51) **Int. Cl.⁷** **G01N 1/14**

(52) **U.S. Cl.** **436/179**; 73/1 G; 73/23.31; 73/863.03; 73/863.83; 422/83; 422/94; 436/134; 436/181

(58) **Field of Search** 422/94, 83; 436/134, 436/177, 179, 181; 73/23.31, 1 G, 31.02, 31.03, 869.02, 863.03, 863.11, 863.83, 864.34, 864.81, 863.61

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,755,663	7/1956	Smith et al. .	
3,469,442	9/1969	Brueckner .	
3,593,023	7/1971	Dodson et al.	73/23.31
3,741,009	6/1973	Bordeaux .	
3,750,472	8/1973	Ducousset .	
3,924,445	12/1975	Konomi et al. .	
3,965,749	6/1976	Hadden et al.	73/23.31
3,975,953	8/1976	Smith et al. .	
4,344,107	8/1982	Webber et al. .	
4,586,367	* 5/1986	Lewis .	
4,637,366	1/1987	Cowles .	
4,706,492	11/1987	Jones, Jr. et al. .	
4,823,591	* 4/1989	Lewis .	
5,756,360	* 5/1998	Harvey et al.	436/179

* cited by examiner

Primary Examiner—Jan Ludlow

(74) *Attorney, Agent, or Firm*—Brooks & Kushman PC

(57) **ABSTRACT**

An apparatus adapted for analyzing exhaust emissions by using a small fraction of a continuously-extracted exhaust sample combined with a pollutant-free diluent through a system of critical flow orifices at a predetermined and precisely controlled flow ratio. A small quantity of gas is extracted from the diluted exhaust gas available which is diluted with the contaminant-free air or nitrogen to produce a mixture having a dew point below ambient air temperature and satisfying the flow requirements of the analysis system. The diluted sample may then be analyzed to obtain the total mass of pollutants through identification of the instantaneous exhaust concentration rate and the exhaust mass flow rate or through identification of the concentration of pollutants collected in a sample bag and the total exhaust volume.

16 Claims, 3 Drawing Sheets

