United States Patent [19]

Ruesch

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[54] **NET OIL COMPUTER**

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[21] Appl. No.: **339,128**

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Related U.S. Application Data

[63] Continuation of Ser. No. 235,234, Aug. 23, 1988, abandoned, which is a continuation of Ser. No. 916,780, Oct. 9, 1986, abandoned.

[51] Int. Cl.⁴ G01F 1/74
[52] U.S. Cl. 73/861.04
[58] Field of Search .... 73/861.04, 32 A, 861.35

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,689,989 9/1987 Aslesen et al. 73/861.04
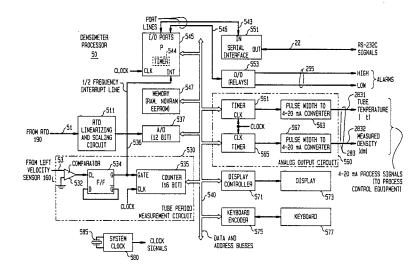
Primary Examiner—Michael J. Tokar
Assistant Examiner—Robert P. Bell
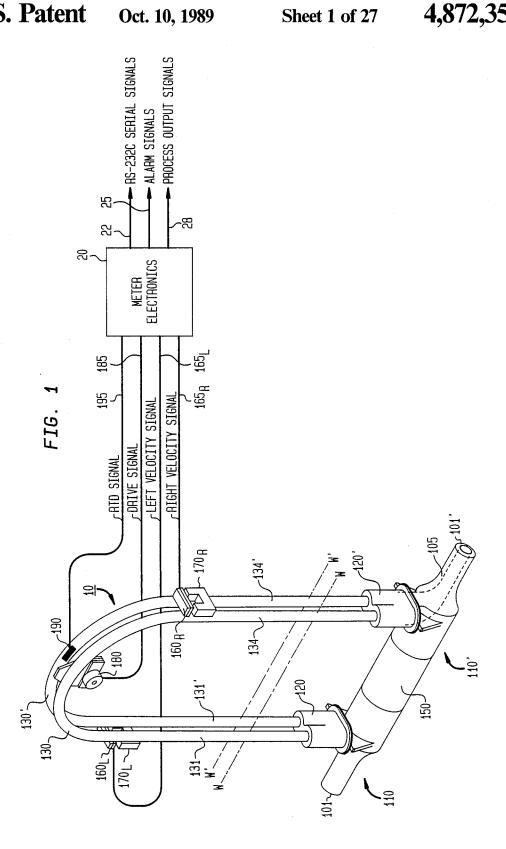*Attorney, Agent, or Firm*—Peter L. Michaelson

[57] **ABSTRACT**

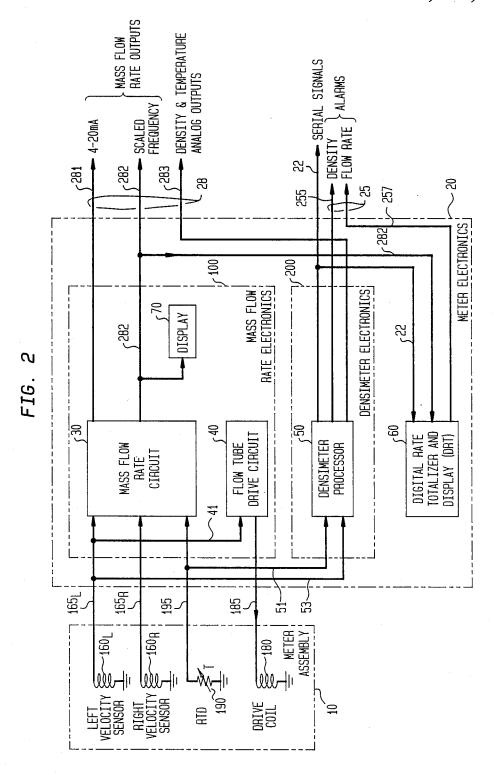Apparatus and accompanying methods for implementing both an accurate densimeter and a net oil computer utilizing a common Coriolis meter assembly is described. In essence, this apparatus measures density of an unknown fluid by first determining the period at which both flow tubes contained within a dual tube Coriolis meter oscillate while the unknown fluid passes therethrough. This apparatus then squares the result. Thereafter, the density of the unknown fluid is determined as a linear function that relates the squared tube period measurement for the unknown fluid, and squared tube period measurements and known density values for two known fluids, such as air and water, that have previously and successively passed through the meter during calibration. When used as a net oil computer, the inventive system obtains mass flow and temperature measurements from the same flow tubes. By using measured density and mass flow values of an oil-water emulsion that flows through the same Coriolis meter, the inventive system can advantageously provide both volumetric and mass based measurements of the flow rate and totalized flow of the entire emulsion and of the individual water and oil components present therein.

36 Claims, 27 Drawing Sheets

FIG. 1

RS-232C SERIAL SIGNALS

ALARM SIGNALS

PROCESS OUTPUT SIGNALS

22

25

28

20

METER ELECTRONICS

195

185

165_L

165_R

RTD SIGNAL

DRIVE SIGNAL

LEFT VELOCITY SIGNAL

RIGHT VELOCITY SIGNAL

10

170_R

134'

W'

W'

120'

105

101'

190

160_R

134

110'

180

131'

120

130'

130

150

160_L

170_L

131

W'

W'

101

110

FIG. 2

FIG. 3
MASS FLOW CIRCUIT
30

FIG. 3A
FLOW (POSITIVE DIRECTION)

VELOCITY WAVEFORMS

LEFT VELOCITY SIGNAL

RIGHT VELOCITY SIGNAL

INVERTED LEFT POSITION SIGNAL

POSITION WAVEFORMS

INVERTED RIGHT POSITION SIGNAL

$+V_{ref}$

$-V_{ref}$

V_{LP}

V_{RP}

START INTEGRATE, DOWN   STOP INTEGRATE, UP

V_L

SAMPLE

STOP INTEGRATE, DOWN   START INTEGRATE, UP

V_R

RESET

V_C

OUTPUT FROM INTEGRATOR 345

$+V_{net}$

ZERO VOLTAGE
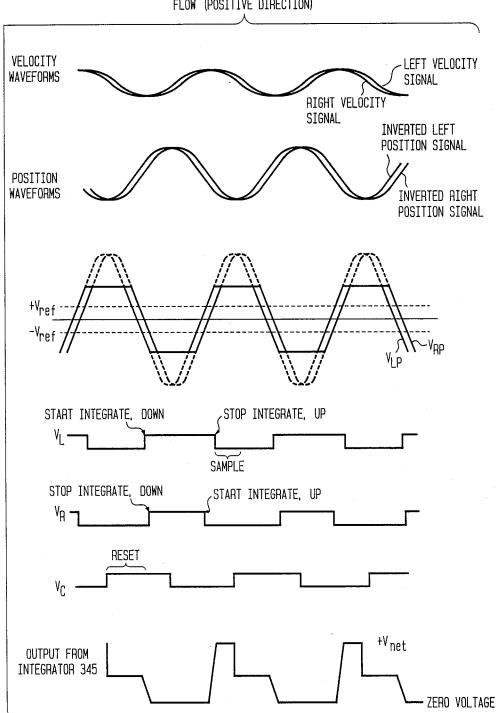
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