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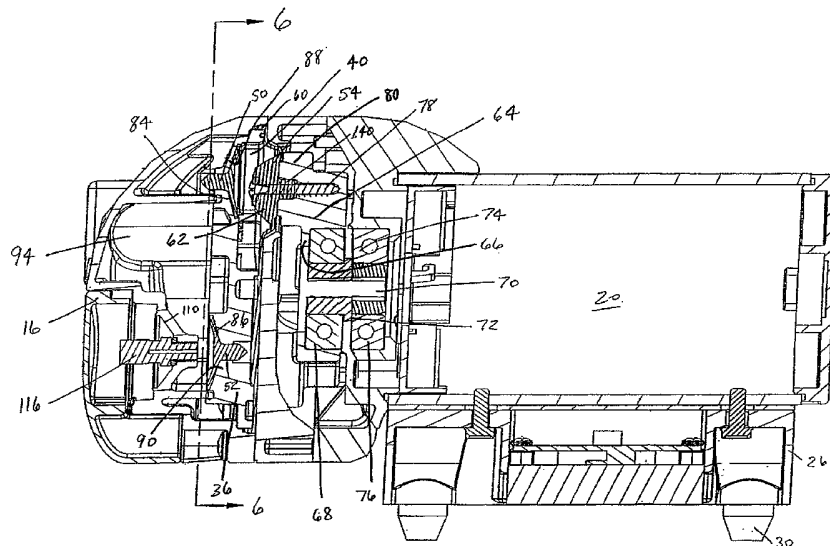
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(54) Title: PUMP AND PUMP CONTROL CIRCUIT APPARATUS AND METHOD



(57) Abstract: A method and apparatus for a pump (10) and a pump control system (200). The apparatus includes pistons integrally formed in a diaphragm (54) and coupled to the diaphragm (54) by convolutes (128). The convolutes (128) have a bottom surface angled with respect to a top surface of the pistons (62). The apparatus also includes an outlet port positioned tangentially with respect to the perimeter of an outlet chamber (94). The apparatus further includes a non-mechanical pressure sensor (116) and a temperature sensor coupled to a pump control system (200). For the method of the invention, the microcontroller provides a pulse-width modulation control signal to an output power stage in order to selectively control the power provided to the pump (10). The control signal is based on the pressure within the pump (10), the current being provided to the pump (10), the voltage level of the battery (202), and the temperature of the pump (10).

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INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER
 IPC(7) : F04B 49/06
 US CL : 417/44.2
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 417/32,44.2, 44.1, 44.9, 43, 45

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,142,741 A (NISHIHATA et al) 07 November 2000 (07.11.2000), column 4 and 5, Figure 1.	1, 4, 5, 9, 11, and 12 ----- 2, 3, 6-8, 10, and 13-17
Y	US 6,406,265 B1 (HAHN et al) 18 June 2002 (18.06.2002), column 1-3 and 5, Figure 1.	2 and 15
Y	US 6,046,492 A (MACHIDA et al) 04 April 2000 (04.04.2000), Abstract, claim 13, Figure 1.	3 and 10
Y	US 5,883,489 (KONRAD) 16 March 1999 (16.03.1999), column 9 Abstract, Figure 1.	8, 16, and 17
X --- Y	US 5,711,483 A (HAYS) 27 January 1998 (27.01.1998), column 1-4, Figure 1.	35,40,41,43,46-49,76-80, and 96-104 ----- 36,37,39,42,44,45
Y	US 6,416,295 B1 (NAGAI et al) 09 July 2002 (09.07.2002), column 1-4, Figure 1.	39
Y	US 3,613,805 B2 (LINSTAD) 19 October 1971 (19.10.1971), column 4 lines 5-47.	42

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T"
"A" document defining the general state of the art which is not considered to be of particular relevance	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

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C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,518,371 A (WELLSTEIN et al) 21 May 1996 (21.05.1996), Figure 1.	65-67, 71, and 72
Y	EP 0 314 249 A2 (SNYDER) 03 May 1989 (03.05.1989), column 1 lines 14-30, column 2 lines 1-30, and column 3 lines 1-10.	65-67, 71, and 72
Y	US 5,883,489 A (KONRAD) 16 March 1999 (16.03.1999), Figure 1.	68, 69, 73, 74, and 75
Y	US 3,613,805 A (LINDSTAD) 19 October 1971 (19.10.1971), column 4 lines 5-47.	70
A	US 6,450,771 B1 (CENTERS et al) 17 September 2002 (17.11.2002), whole document.	65-75
A	US 6,254,353 B1 (POLO et al) 03 July 2001 (03.07.2001), whole document.	65-75
A	US 5,519,848 A (WLOKA et al) 21 May 1996 (21.05.1996), whole document.	65-75
A	US 6,474,949 B1 (ARAI et al) 05 November 2002 (05.11.2002), whole document.	65-75

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-17,35-49,65-80 and 96-104

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

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BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid

Group I., claim(s) 1-17, drawn to a pump control circuit and method for controlling a pump based on reading from a temperature sensor.

Group II., claim(s) 18-34, and 81-83 drawn to a pump control circuit and method for controlling a pump based on battery cable length and voltage.

Group III., claim(s) 35-49, 76-80, and 96-104 drawn to a pump control circuit and method for controlling a pump based on signals from a pressure sensor.

Group IV., claim(s) 50-64, drawn to a pump control circuit and method for controlling a pump based on a high and low flow mode.

Group V., claim(s) 65-75, drawn to a pump control circuit and method for controlling a pump based on pressure using an oscillating control signal.

Group VI., claim(s) 84-95, drawn to a diaphragm pump.

The inventions listed as Groups I. and II.-VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group I., is based on temperature signals while the pump controller in group II., is based on properties of a battery supply. The special technical feature in Group I. of a temperature sensor and control based on temperature signals lends this group to be distinct from groups II.-VI.

The inventions listed as Groups II., and the remaining groups I. and III.-VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group II., is based on properties of a battery supply. The special technical feature in Group II., of a battery supply, a first and second cable, a battery voltage detector, a reverse polarity damage component, and control based on battery voltage lends this group to be distinct from groups I., and III. -VI.

The inventions listed as Groups III., and the remaining groups I., II, and IV-VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group III., is based on signals from a pressure sensor given a shut-off pressure level. The special technical feature in Group III., of a pressure sensor and controller based on pressure signals lends this group to be distinct from groups I., II., and IV. -VI.

The inventions listed as Groups IV., and the remaining groups I., - III, V. and VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group IV., is based on operating modes of high and low flow. This special technical feature in Group IV., lends this group to be distinct from groups I., - III., V., and VI.

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The inventions listed as Groups V., and the remaining groups I. -IV. and VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group V., is based on based on pressure using an oscillating control signal. The special technical feature in Group V., of a microcontroller generating oscillating signals and a shut off signal lends this group to be distinct from groups I.,-IV., and VI.

The inventions listed as Groups VI., and the remaining groups I. -VI. do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons, the pump controller of group III., is a diaphragm pump whereas the other invention groups are directed to control devices for a pump. The special technical features in Group VI., of the diaphragm, the pistons, and the pump, lends this group to be distinct from groups I.,-V.