(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 041 856**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **81302527.7**

(22) Date of filing: **08.06.81**

(51) Int. Cl.³: **G 08 C 23/00**

(30) Priority: **10.06.80 US 158092**

(43) Date of publication of application:
16.12.81 Bulletin 81/50

(84) Designated Contracting States:
AT DE FR

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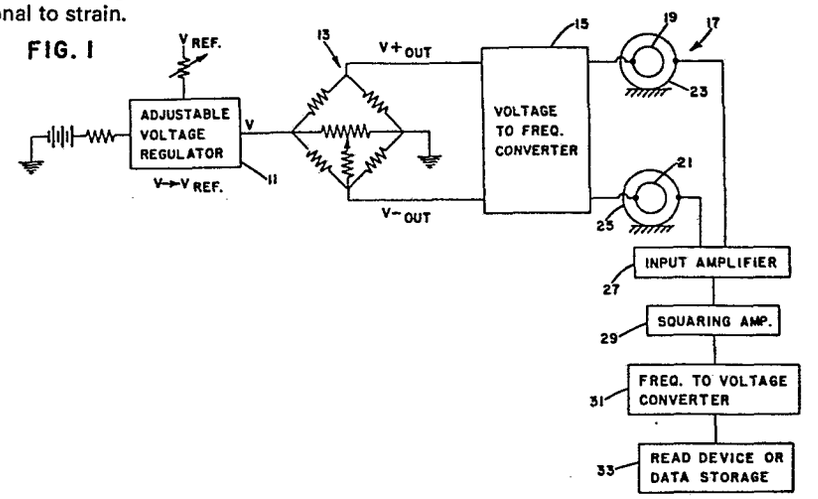
(54) Telemetry apparatus.

(57) The output from a strain gauge bridge 13 on a shaft is transmitted to a fixed detector 27, 29, 31 using only two coupling capacitors 19, 23, and 21, 25, each with a rotating plate 19 or 21 and a fixed plate 23 or 25, by applying the voltage from the bridge to a voltage to frequency converter 15 also mounted on the shaft. The converter 15 provides a square wave signal with frequency proportional to strain. This is received by the detector circuit as a differentiated square wave. A squaring amplifier 29 and frequency to voltage converter 31 reconstitute a voltage proportional to strain.

FIG. 1



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TELEMETRY APPARATUS

This invention relates to telemetry apparatus comprising a strain gauge mounted on a first of two parts and providing an alternating signal to a detector circuit mounted on the second part by way of a capacitive coupling between the two parts.

It is often necessary in evaluating the dynamics of a system to collect strain data. For example, one may wish to obtain torque and bending strain data from a vehicle drive shaft. A conventional method to collect strain data from a vehicle drive shaft under operating conditions is to mount a bridge circuit, of which one element is the strain gauge, strategically on the shaft. The problem then exists of transferring the data from the rotating shaft, i.e. the aforementioned first part, to the body of the vehicle, i.e. the second part. One solution (e.g. US-PS 3 824 845) is to use slip rings but slip rings are a source of trouble in that the electrical connection provided thereby tends to deteriorate. Another solution (US-PS 3 668 673) applies the output from the strain gauge bridge to a sub-carrier oscillator (SCO) whose deviation from its centre frequency is proportional to the strain imposed on the strain bridge. The output from the SCO is used to modulate a radio frequency oscillator (RFO) whose output is transmitted to a receiver. The use of a radio frequency signal can create disturbance to other vehicle electrical components. Also, the transmitted radio frequency can be reflected off metal vehicle components to create noise problems in the received signal.

In another solution, which is in accordance with the introductory part of claim 1, (US-PS 3 224 257) the strain gauge circuit is energised by an alternating signal from an oscillator mounted on the second part and capacitatively coupled to the strain gauge circuit on the first part. Such an arrangement requires two capacitive couplings, each involving two capacitors, to couple the energising alternating signal to the strain gauge circuit and to couple the output alternating signal to the detector circuit. Four capacitors in all are thus required, each with one plate on the first part and one plate on the second shaft. This makes the apparatus complicated.

An arragement is also known (US-PS 3 303 701) which requires only two coupling capacitors for the case of a temperature measurement, employing a resonant circuit on the first part. The frequency of the resonant circuit varies in dependence upon a temperature sensitive element therein and the resonant circuit is coupled by the capacitors to an amplifier circuit on the second part to form an oscillator whose frequency indicates the temperature. However the relationship between frequency and temperature is non-linear.

The object of this invention is to provided an apparatus according to the introductory part of claim 1 which only requires two coupling capacitors but which can provide a linear representation of the measured strain and this object is met by the characterising features according to which the strain gauge circuit includes a voltage to frequency converter providing the alternating signal in response to a voltage proportional to the strain.

In the preferred practice of the invention, a bridge network is secured on a part subjected to strain, such as a shaft. The output from the bridge network, which is proportional to element strain, is delivered to a voltage to frequency converter. The output from the frequency converter is in the form of a square wave with a frequency proportional to the strain. The output from the frequency converter is delivered to a first set of capacitance rings placed about the part for which strain readings are desired. A second set of stationary capacitance rings placed around the first rings provide capacitive coupling utilizing air as the dielectric. The received signal is in the form of a differentiated square wave and is delivered to a squaring amplifier and thereafter to a frequency to voltage converter, wherefrom the signal is delivered by a readout device.

The invention will be described in more detail, by way of example, with reference to the accompanying drawings in which:

Fig 1 is a block diagram of a telemetry apparatus embodying the invention,

Fig 2 is a diagram of a square wave having a frequency proportional to element strain,

Fig 3 is a diagram of a differentiated square wave having a frequency proportional to strain.

Referring to Fig 1, a voltage source shown as a battery supplies a voltage to an adjustable voltage regulator 11 of conventional design which delivers a voltage to a bridge network 13. The bridge network 13 is strategically located on the vehicle drive shaft (not shown) in a conventional manner and includes as one resistor thereof a strain gauge. The bridge produces an output voltage drop across the bridge network 13 proportional to shaft strain. The output from the bridge network 13 is delivered to a voltage to frequency converter 15, such as manufactured by Analog Devices, Model AD537. The output from the voltage to frequency converter 15 is in the form of a square wave having frequency proportional to shaft strain (illustratively shown in Fig 2). The output from the frequency converter 15 is delivered to a capacitive coupling system 17.

The capacitive coupling system 17 includes first and second capacitance rings 19 and 21 secured around the periphery of the shaft in a conventional manner. All of items 11, 13, 15, 19 and 21 are mounted on the shaft. Third and fourth capacitance rings 23 and 25 are fixed in close proximity to the associated rings 19 and 21 respectively. The frequency modulated voltage across rings 19 and 21 as received from the voltage to frequency converter 15 is transmitted to rings 23 and 25 using air as a dielectric. The signal output from rings 23 and 25 is in the general form of a differentiated square wave (Fig 3). The signal from rings 23 and 25 can then be delivered to an input amplifier 27 to increase its level. The signal can be processed further by passing it to a squaring amplifier 29, frequency to voltage converter 31 and then to a recorder or direct readout device 33. All of items 23, 25, 27, 29, 31 and 33 are mounted on the vehicle body.

CLAIMS

1. Telemetry apparatus comprising a strain gauge circuit mounted on a first of two parts and providing an alternating signal to a detector circuit mounted on the second part by way of a capacitive coupling between the two parts, characterised in that the strain gauge circuit (11, 13, 15) includes a voltage to frequency converter (15) providing the alternating signal in response to a voltage proportional to the strain.

2. Telemetry apparatus according to claim 1, characterised in that the detector circuit (27, 29, 31) includes a frequency to voltage converter (31) which converts the altenating signal back to a voltage proportional to the strain.

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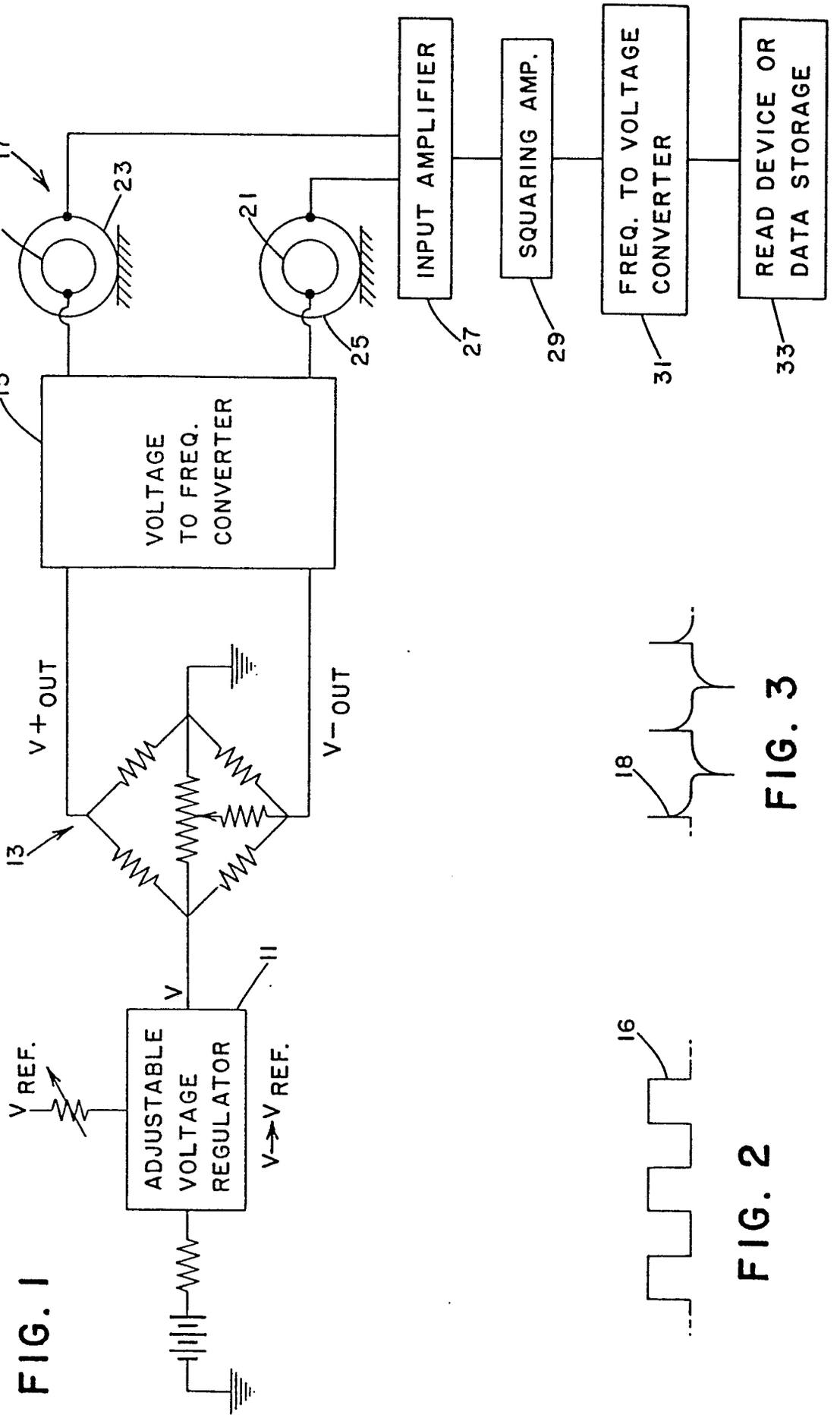

FIG. 1

FIG. 2

FIG. 3

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EUROPEAN SEARCH REPORT

Application number
EP 81 30 2527

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	INSTRUMENT PRACTICE, vol.23, no.5, May 1969 LONDON (GB) "Short-range Telemetry" page 369 * the whole article * -----	1,2

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

G 08 C 23/00

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

G 08 C 23/00
19/26
G 01 L 1/22

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10-09-1981	WANZEELE