timers can be ineffective. Another system developed was based on monitoring the level of the fruit in the last digester, on the processing line, and from this signal automatically controlling the speed of the stripper feeder. The system involved deepening the digesters by 1 metre - this section was not fitted with stirring arms and the digesters were driven from the bottom. At a pre-determined interval of time a weight, secured to the end of a wire cable, was lowered into the digester and as soon as the weight touched the fruit the tension in the wire cable was reduced and the driving mechanism of the cable stopped, then reversed returning the weight to its original position above the top of the digester. The travel of the weight was automatically analysed and a signal sent to the bunch feeder drive to lower or raise the speed if necessary.

In conclusion it must be stressed that this article may not have covered all the the systems adopted for digester level control. It was written following a request from one of our readers for our views on auto-feeding systems giving advantages and disadvantage of the various systems.

(J.H. Maycock)

QUALITY PARAMETERS

CAROTENE CONTENT

The deep red colour in crude palm oil is due to the presence of carotenoids. The average content of carotenoids in Malaysian Palm Oil is about 500 - 700 mg/kg of which about 90% is made up of α- and β- carotenes. The carotenes are important minor constituents as they are known to be provitamin A and also possess certain anti-carcinogenic properties. However the effect of β -carotene on the oxidation of unsaturated fatty acids is uncertain; some consider it as an antioxidant while there are others who consider it a pro-oxidant. Several projects are now being carried out in PORIM to find economical ways to recover carotenes from crude palm oil.

Determination

As carotenes contain conjugated double bonds, they absorbed light strongly, displaying characteristic uv-visible spectra. As β-carotene is the major component of carotenoids, the content in palm oil is defined and expressed as β -carotene in mg/kg.

The palm oil sample is melted, filtered and dissolved in a suitable solvent (isooctane or hexane) in a 25 ml standard flask. The absorbance at 446 nm of the solution is then measured against the solvent blank. The result is expressed as mg/kg β-carotene and is calculated from:

$$25 \times \frac{383}{100W} (A_s - A_b)$$

Where A_s = Absorbance of the sample solution
A_b = Cuvette error
W = Weight of sample in g

Factors Affecting Carotene Content in Crude Palm Oil

1. Genetic Variation
2. Degree of ripeness of fruits
3. Climatic and geographical factors
4. Degree of oxidation

Carotene and Palm Oil Processing

1. Carotenes are partially removed during neutralisation and earth bleaching of crude palm oil.

2. During deodorisation, carotenes are decomposed into colourless products. This is sometimes known as 'thermal bleaching'.

3. It has been reported that complex reaction products which are difficult to be removed by bleaching earth, are formed between carotenes and unsaturated fatty acids in crude palm oil during oxidation. Steps must thus be taken to minimise palm oil oxidation during storage. The recommended precautions are essentially similar to those published in the previous issue No.9 of the Engineering News.

(T.S. Tang)

PROCESS AUTOMATION

FLOW TECHNOLOGY TODAY

The measurement of various process parameters is vital for improvement of efficiency, safety and control of the plant. The palm oil industry provides a real challenge to manufacturers of measuring equipment because process conditions are unique to this industry. It is important that sensing elements and transmitters are selected properly and tried before making investments in automation of mills. Beginning with this issue of Engineering News, Endress & Hauser GmbH & Co. will provide a series of articles on sensors and transmitters for the measurement of flow, level, pressure and bulkflow. The first article in this series is on flow measurement.

Introduction

Incentives are strong for accurate and reliable flow measurements in the palm oil industry. Monitoring of steam, crude palm oil, water, effluent flow and chemical dosing are essential for conservation of energy, improving performance and controlling pollution in palm oil mills. Palm oil refineries and downstream processing plants especially require a large number of flow measurements.

Flowmeter selection requires careful attention to several factors. The following are some basic considerations:

- o Process Conditions - Flowmeter should be able to meet process requirements of pressure, temperature, viscosity, conductivity and type of liquid.

- o Installation - Should be easy to install and require minimum mechanical work. Necessary straight lengths should be available.

- o Maintenance - Should be maintenance-free with no moving parts, self-diagnostics, easy checks, and preferably programmable with microprocessor controls.

- o Required Accuracy - The accuracy should meet the process requirements and should take care of rangeability, repeatability and ambient conditions.

- o Cost - Total cost should include price of the flowmeter and cost of installation and maintenance.

Some Recent Types of Flowmeters

1. Liquids

   (a) Mass flow - Direct mass flowmeters

   (b) Volume flow - i) Electromagnetic flowmeters (for conductive liquids)

   ii) Vortex flowmeters (for liquids with low viscosity)

2. Steam and Gas - Vortex flowmeters

Mass Flowmeters

Process engineers in the palm oil industry are now taking a greater interest in the weight of liquids rather than volume because of variations in density with temperature. Flowmeters that measure mass directly have been developed into industrial process flowmeters. They offer considerable advantages over volume meters *(Fig. 1)* used with density meters because of reduced measurement uncertainty and low installation and calibration costs *(Fig. 2)*.

In 1835, an assistant professor of analysis and mechanics at the Ecole Polytechnique in Paris, Gaspard Gustave de Corioles, quantified the natural phenomenon which causes objects moving freely over the surface of the earth to appear to curve. This effect is called the Coriolis Effect or Coriolis Force. In a system (Fig. 3) rotating with the angular velocity w, the mass moves radially with the velocity v. Because of this a tangential force F_c acts on the mass as follows :

$$F_c = 2mwv$$

With the new m-point mass flowmeter from E & H (Flowtec), the mass of a liquid can be measured using the Coriolis principle when it flows through straight, parallel, oscillating twin pipes made of titanium *(Fig. 4)*. The new m-point mass flowmeter design features the first mass flowmeter where the metering pipes within the housing are without any bends or loops.

By excitation an absolutely straight pipe will be set into resonance. At two precisely defined points, near the beginning and the end of the pipe, an infrared sensor is placed to detect the phase of the vibration. When no mass flows though the pipe, the phase of the two sensors coincide. A particle of the liquid flowing into the pipe will undergo a lateral acceleration. Its inertia will attenuate the vibration at the beginning of the pipe. As the particle passes through the pipe, it will then transmit the absorbed energy of vibration into the pipe, the vibration of which will be intensified resulting in a phase shift.

Two optical sensors measure the phase difference which is directly proportional to the mass flow. By using two metering pipes vibrating in antiphase it is possible to make the measuring unit immune to vibration interference.

The merits of the new E & H m-point mass flowmeter can be summarized as follows:

- o Straight pipes, i.e. ease of cleaning and a low pressure drop.

- o Titanium as a material of construction offers a good chemical resistance and a good resistance against alternating working stresses.

- o A two-core Exi transmission which means easier installation.

- o An interference-free signal transmission of mass flow, temperature, density and error messages.

- o A high resonant frequency of the titanium pipes of over 600 Hz, i.e. insensitivity to the usual industrial vibrations of 50-200 Hz.

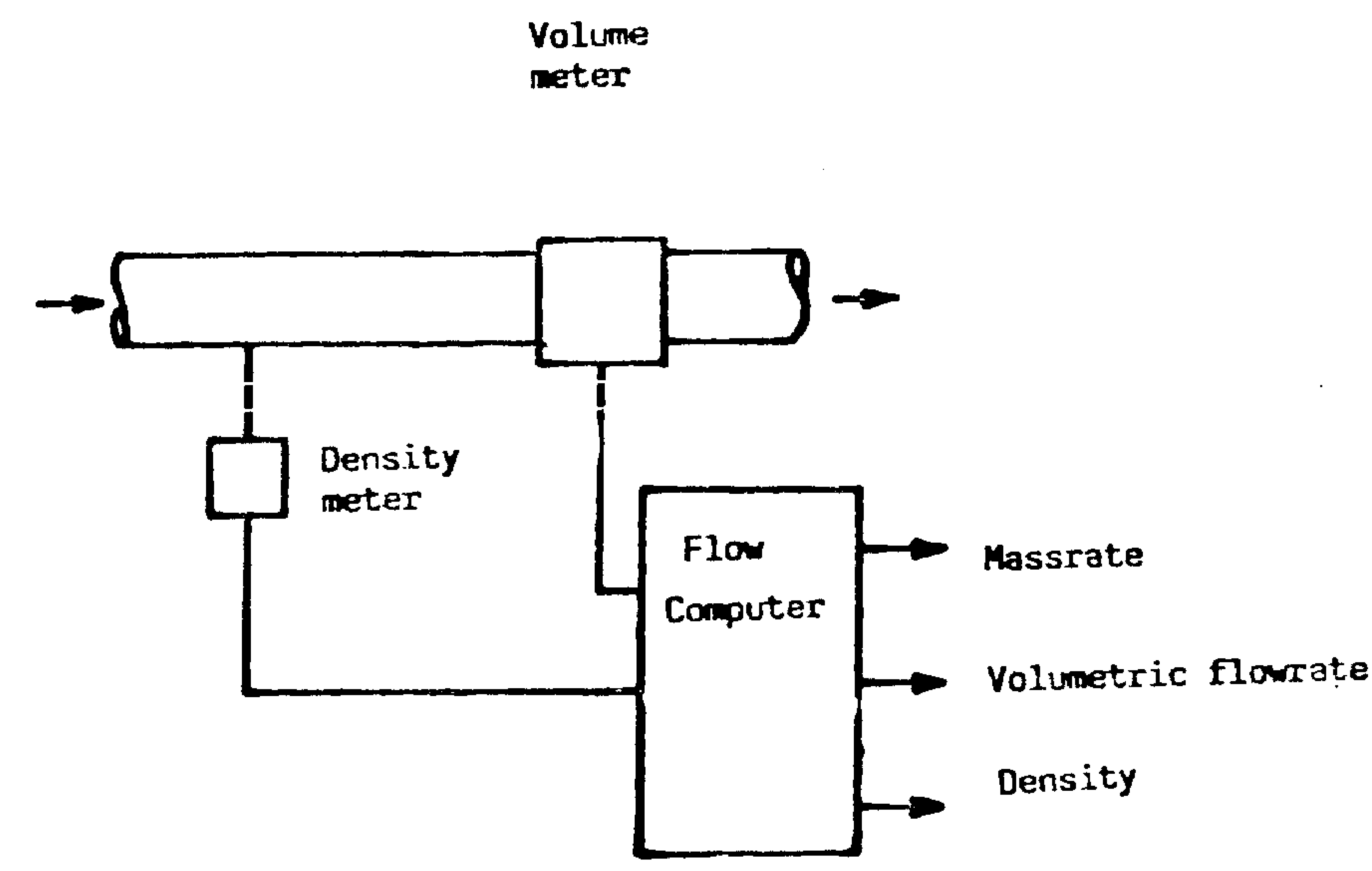


FIGURE 1.

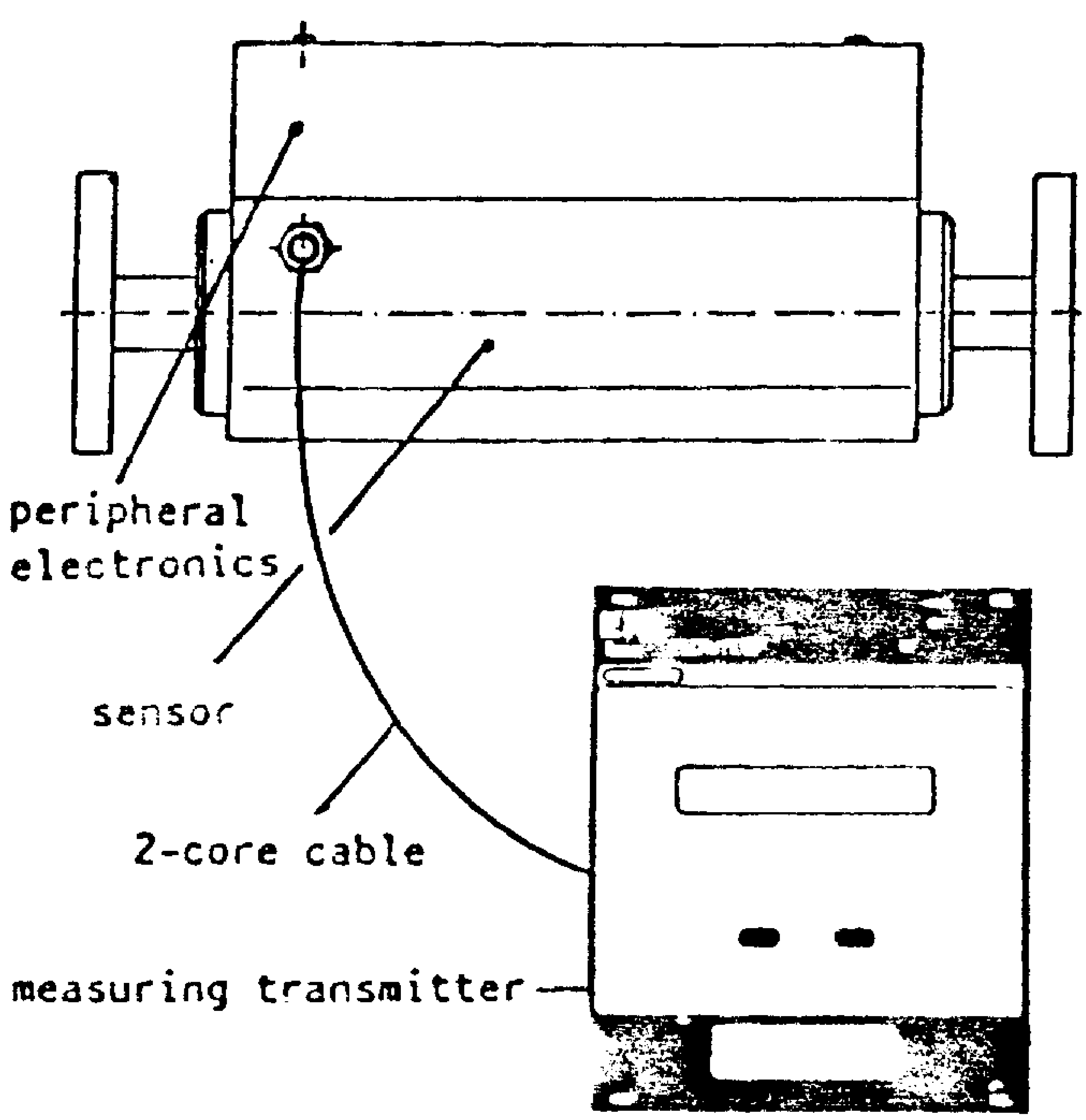


FIGURE 2.

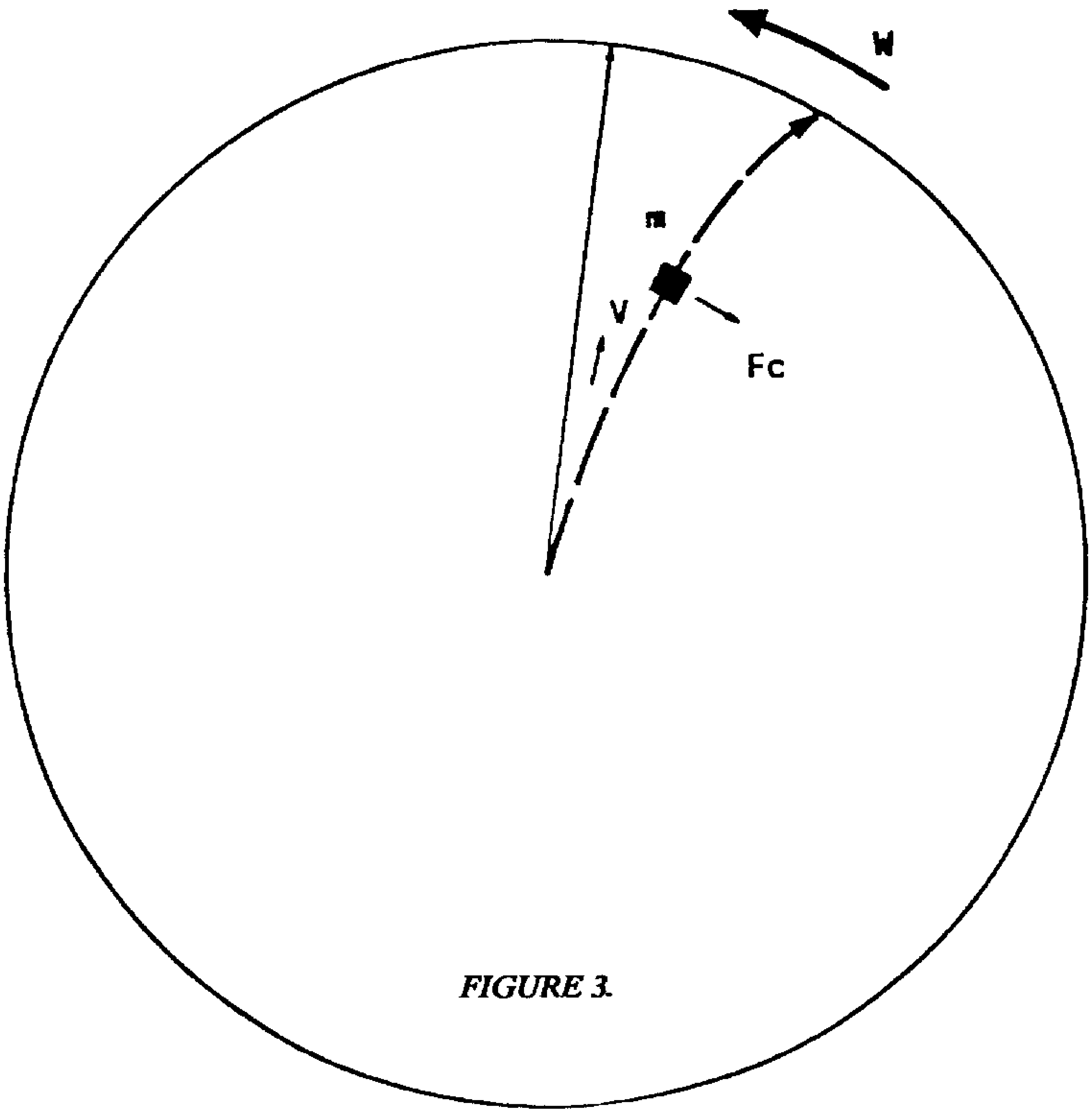
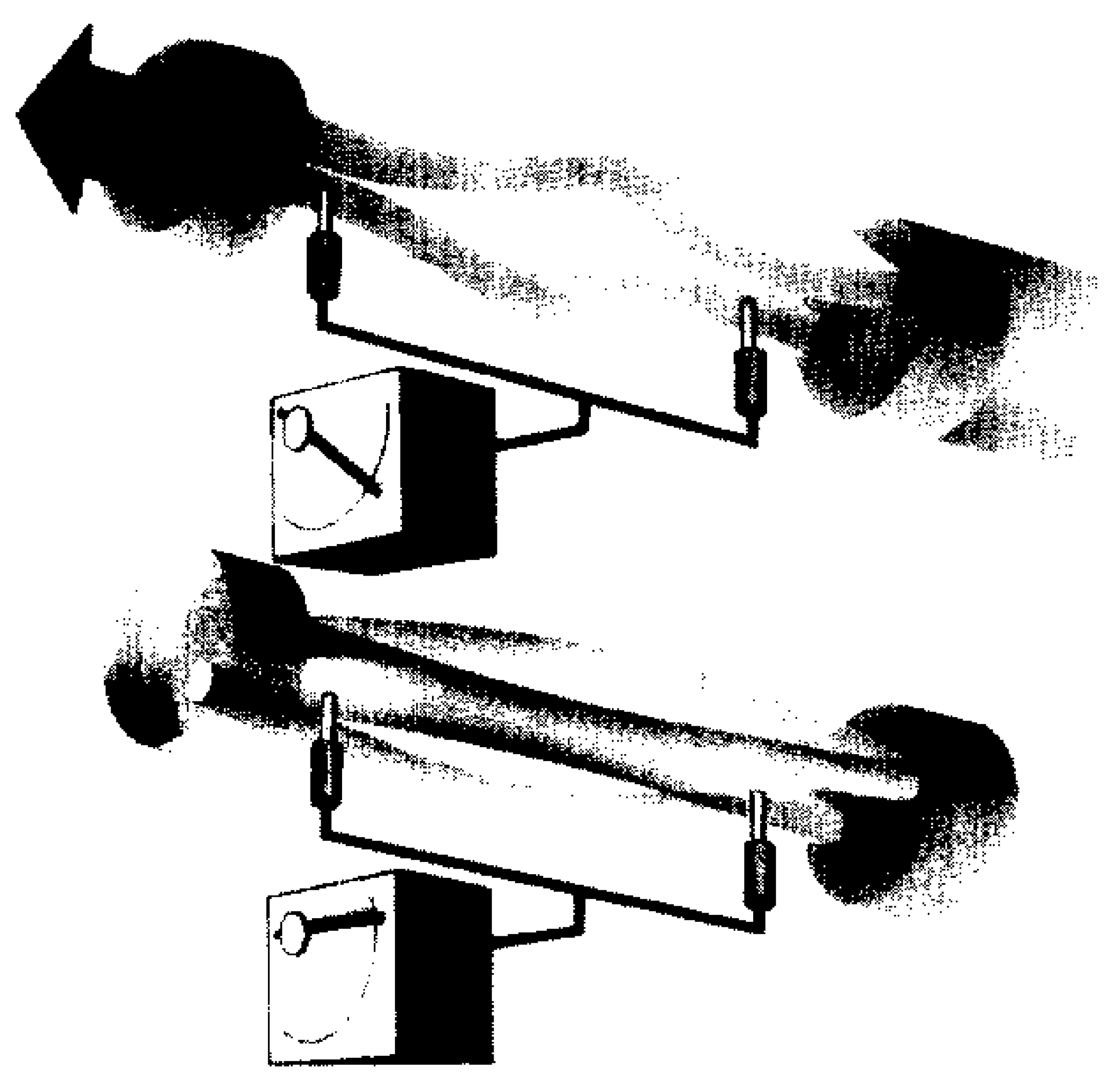


FIGURE 3.

FIGURE 4.



Schematic display of **m-point** operating principle (flow measurement employing the gyrostatic principle/coriolis flowmeter)

- o The instrument not only measures the mass but also the temperature and density of a liquid.
- o Accuracy +/-0.25% of flow rate.
- o Flow measurement is independent of pressure, temperature, density and viscosity.

Electromagnetic Flowmeters

An electromagnetic flowmeter consists of a non-magnetic stainless steel pipe lined with an insulating material. A magnetic field is produced across the tube by exciting coils arranged around the outside. Liquid passing through the pipe becomes the conductor. Two electrodes opposite each other and flush with the lining detect the voltage induced by the liquid. The induced voltage is proportional to the velocity of the liquid *(Fig. 5)*.

Lining and electrode materials can be of corrosion resistant material at little additional cost. This means that electromagnetic flowmeters can be used on many corrosive and aggressive liquids which are difficult or impossible to meter with most other types of flowmeters.

Electromagnetic flowmeters are inline devices and are available in sizes DN 3mm to DN 200mm and work satisfactorily within 0.5 m/sec to 10 m/sec velocity range.

Electromagnetic flowmeters are ideal for conductive liquids with conductivity more than 5 us/cm. Advantages of this measuring technique are :

- o No pressure loss.
- o No moving parts, i.e. maintenance free.
- o Measures abrasive and corrosive products and liquids with particles in suspension.
- o High accuracy (+/-0.5% of flow rate).
- o Stable zero.
- o High turn down ratio.
- o May be flooded (IP68 protection).

There have been tremendous developments in electromagnetic flowmeter technology in last 10-15 years. The flowmeters with AC field excitation consuming powers up to 60 - 100 watts are now available with DC excitation consuming only 7 - 10 VA. It is important to look for following features before selecting a particular electromagnetic flowmeter.

1. ***Excitation***

   The excitation should be DC pulsed with automatic zero correction. When driving the electromagnetic flowmeter with a pulsed positive and negative DC current of low frequency, intervals of steady state field "S" are created *(Fig. 6)*. During these intervals all internal interference is absent and signal cable losses cease. Therefore, all of the zero drift effects disappear.

2. ***Protection***

   An electromagnetic flowmeter consists of a flow sensor and converter and these are available in several versions and protection, *e.g.*

   Compact - sensor and housing are integrated in one unit with IP65 protection.

   Separate Version - sensor and convertor are separated. Sensor is available in submersible IP68 protection.

3. ***Electronics***

   Introduction of microprocessor-based electronics makes start-up and operation extremely simple. The outputs, both 4 - 20mA and scaled pulse, should be freely programmable.

Vortex Meters

Vortex meters are based on a natural phenomenon known as vortex shedding. When a fluid flows past an obstacle vortices are shed from alternative sides of the obstacle. The frequency at which they are shed is directly proportional to velocity.

Vortex meters combine in one meter many advantages and features not found collectively in other flowmeters.

Its principle attributes are long-term accuracy and repeatability, good rangeability and stability. Measurement is largly independent of viscosity, density, pressure and temperature. The most remarkable feature certainly is that the same vortex meter can be used on liquid, gas or steam within normal accuracy tolerances!

Two of the most important parts of vortex flowmeters are bluff body and sensor and these should be checked before making a selection.

Delta-Shaped Bluff Body

Bluff bodies are unstreamilined obstacles placed into fluid flow. Generally the shape of the bluff body determines the linearity of relationship between flow velocity and shedding frequency.

Alain Rodely, an American researcher, proved that with delta-shaped bluff bodies high linearity could be achieved. The reason for this is that the point of detachment is stable. A linear output can be obtain irrespective of changes in viscosity, density and other fluid properties.

Differential Switched Capacitor (DSC) Sensor

This type of sensor represents the latest technology. The sensor *(Fig. 7)* is flanged to the meter body and a special gasket isolates the measured fluid from the meter. The lower sensor section is an oscillating tongue