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"Field Experience with Flare Gas Meters"

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FIELD EXPERIENCE WITH FLARE GAS METERS.

INTRODUCTION

All the Greater Ekofisk production is processed at Ekofisk Center. The Ekofisk platforms are preprocessed at Ekofisk FTP on the South end of the Ekofisk Center complex and West Ekofisk at Ekofisk Tank before this production joins the remaining Greater Ekofisk production for the final two stages of separation and treatment at Ekofisk Tank.
All of these processes have relief system into the flare header system with flare towers at the North and South end at Ekofisk. The gas reliefs, vents and leaks into the flare header system are measured through three flare meters in the South direction and three flare meters in the North direction. Each meter run is equipped with an insertion turbine flowmeter and a densitometer for mass flow determination.

From a management and operation point of view a reliable flare gas meter is of great importance. One of the reason for this is that in addition to using the meters for the lost gas accounting, the flare meters are also used as tools to detect abnormal flaring of gas. This abnormal flaring might come from a leaky valve. The flare meters will make the operators aware of the high flaring and they may find the cause and reduce the loss of gas to the flares.
This mean that the flare meters should be capable of measuring a wide range of velocities occurring in the flare pipes.

The flare gas meter on Ekofisk was original designed with a single insertiontype turbine flowmeter. With the limitation in rangeability for a single turbine meter, this system was not able to handle both the high and the low end of the actual flaring. In an effort to increase the rangeability, a dual flare turbine meter was tested and has now been used in normal operation over a period of five years.

In this paper I will share our field experience on this dual flare turbine meter. I will also describe some of the initial problems with the implementation of the dual probe in the original single turbine meter system.
Furthermore I will address a mechanical problem with the dual rotor probe switching system, and a modification carried out by us. Finally some ideas of how to use a dual flare turbine probe in connection with a modern flow computer will be discussed.

An evaluation of those parameters which are significant in the selection and application of a turbine meter system for flare meters, is not a part of this paper.

ORIGINAL FLARE METER SYSTEM

The original flare metering system on Ekofisk was designed with a turbine flowmeter and a densitometer. Both of these instruments are of an insertion type that may be inserted into or removed from the line under normal operating condition. A full bore valve is used between the units and the pipeline, so that the entire assembly may be removed for maintenance or repair without interrupting the flow.

The turbine flowmeter consist of a bearing mounted rotor in a housing through which the fluid to be measured is passed. The rotor spins with a rotation speed proportional to the velocity of the fluid flowing through the meter. An electro-magnetic pickup and associated electronics detect the passage of each rotor blade and generates a pulse. The number of pulses is then proportional to the total actual volume of flow, and the frequency of the pulses is proportional to the actual volumetric flow rate.

The metering system on Ekofisk is based on mass calculation. The densitometer is therefor used to give the additional information needed to convert the actual volumetric flow rate from the turbine meter to a mass flow rate.

The block diagram show the Flare metering system on Ekofisk.

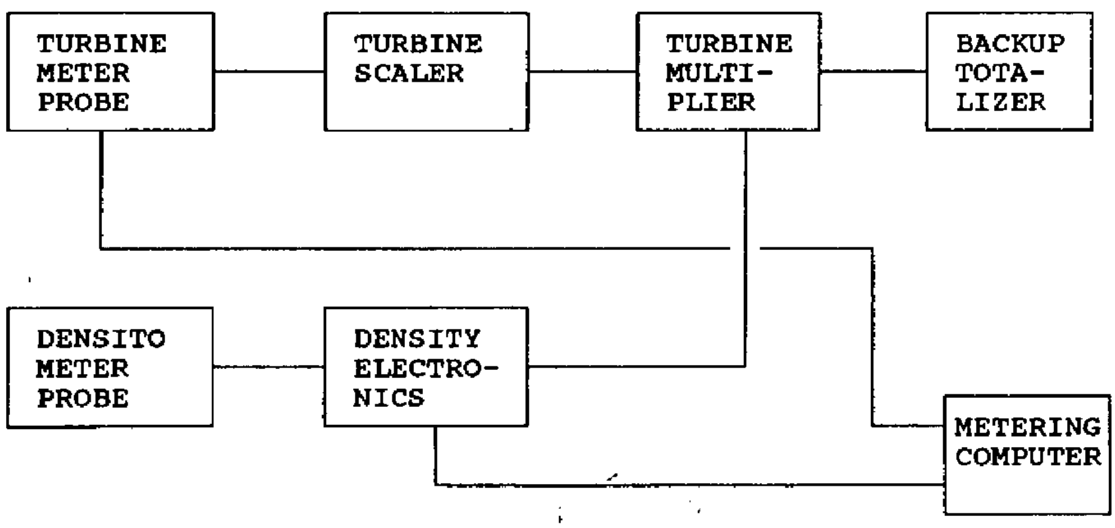

Figure 1 Block diagram of flare metering system on Ekofisk

The turbine meter should be installed with 15 pipe diameters straight section upstream and 10 pipe diameters straight section downstream of the meter.
According to the vendor, their design is based on the average velocity being at .12x pipe diameter from the pipe wall in a pipe of average roughness. The centerline of the rotor must be inserted into the pipe to this depth.
Since the probe obscures a portion of the line, the velocity through the probe is slightly higher than it is either upstream or downstream.
The calibration sheet furnished with the turbine meter defines the velocity at the turbine for specific output frequencies. This must be adjusted according to the meter pipe size.

The velocities are related by:

$$V_pA_p = VA$$

where

Vp = velocity at probe as indicated by output frequency

Ap = unobscured area at probe

V = velocity in unobscured flow line

A = cross sectional area of flow line

One of the important part of the turbine flowmeter is the rotor bearing. Basically, there are three types of bearings used for this type of turbinemeter: the Journal bearing, the Ball bearing and the pivot bearing.
The three types of bearings are shown in figure 2

The meters used on Ekofisk are made with ball bearing. These bearings give a low bearing drag effect to the turbinemeter. Such meters have wide rangeability and good linearity characteristics. The bearings are also easily replaced, and the replacement has a nearly negligible effect on meter performance, so that new bearings can be installed without recalibration. This is also part of the normal maintenance prosedure for the flare gas meters on Ekofisk.

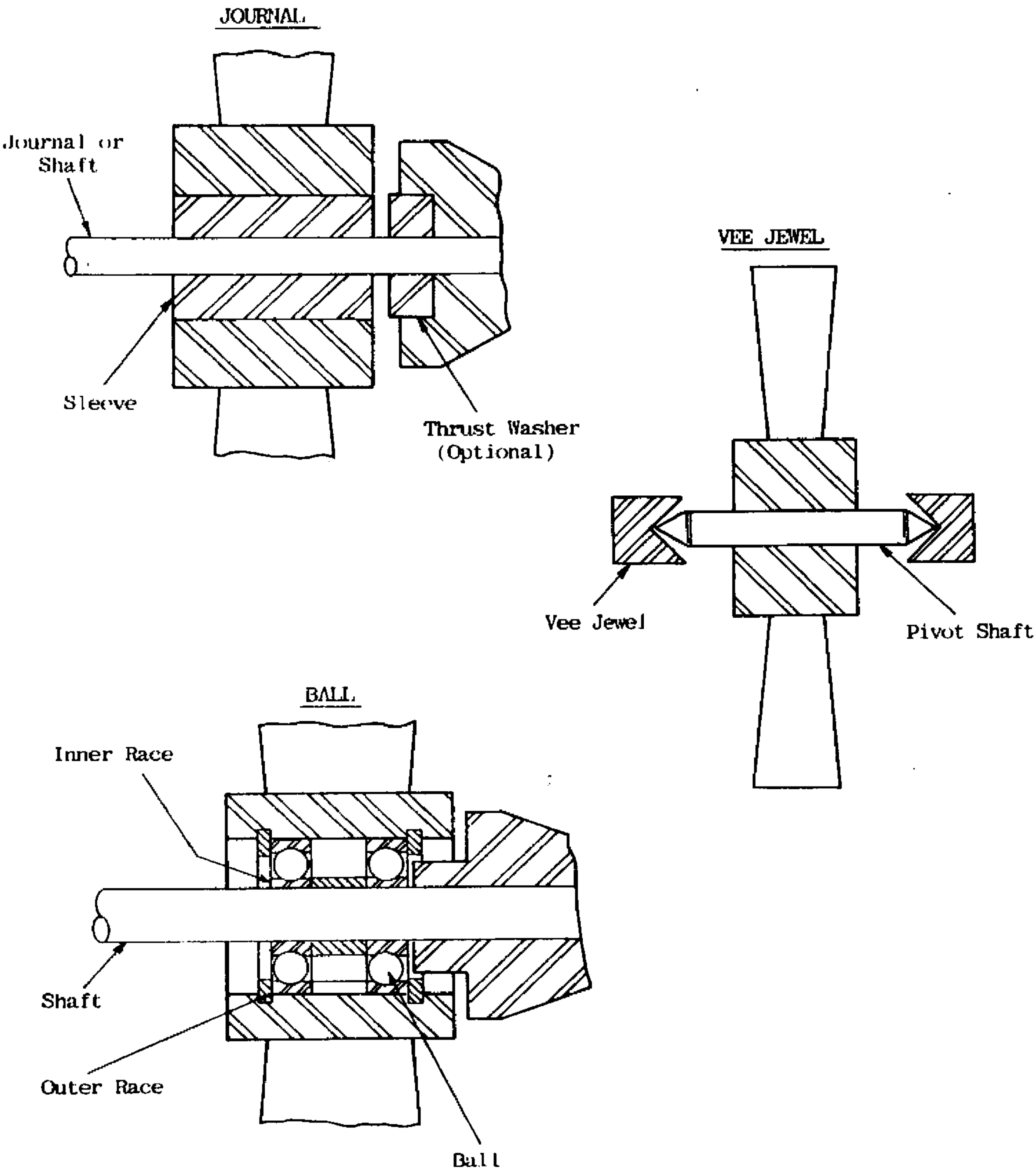

Figure 2 Bearing types used for turbine flowmeter

DESCRIPTION OF THE DUAL FLARE PROBE

The dual flare probe is based on the same principles as the single probe, except it has two separate rotors for measuring respectively high or low flow rates. The two rotors are mounted with the flow direction 90° to each other.
The unit has a switching box which turns the probe between the high and low flow rate rotors. The switching is accomplished through a mechanical linkage that turns the probe. The linkage is operated by instrument air pressure and activated by a solenoid valve that gets its signal from the associated instrumentation, where the switching points are set.
The switching points are the points at which the dual probe switches from the low-flow rotor to the high-flow rotor or vice a versa.
The switching points are adjusted in % of the flow range of the two rotors.

The dual flare probe is supply with the following rotors:

Low flow range : 1-inch rotor with range 1.5 to 15 Ft/Sec

High flow range: 1/2-inch rotor with range 15 to 150 Ft/Sec

Figure 3 shows the mounting of the two rotors in the dual flare probe.

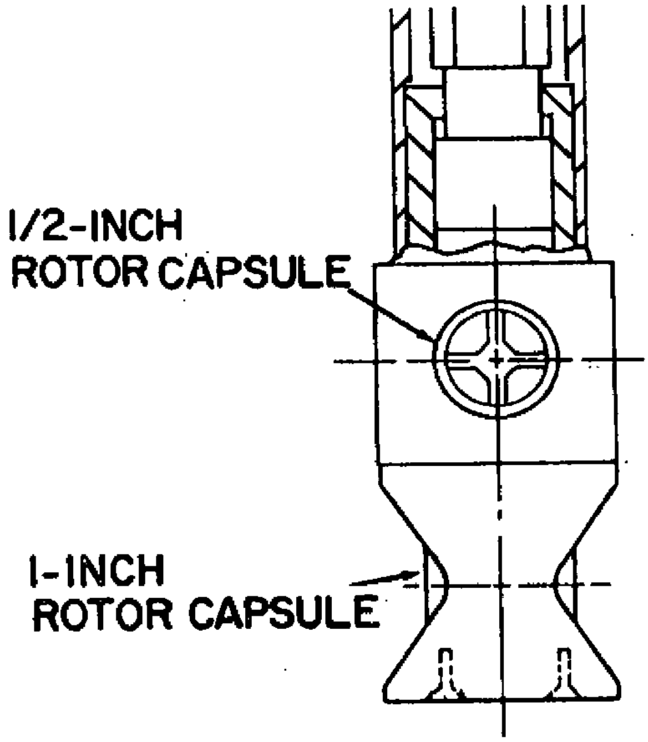

Figure 3 Dual flare probe rotor assembly

INTERFACING OF DUAL FLARE PROBE IN ORIGINAL SYSTEM

The interfasing principle of the dual flare probe in the original flare meter system is shown in the block diagram below.

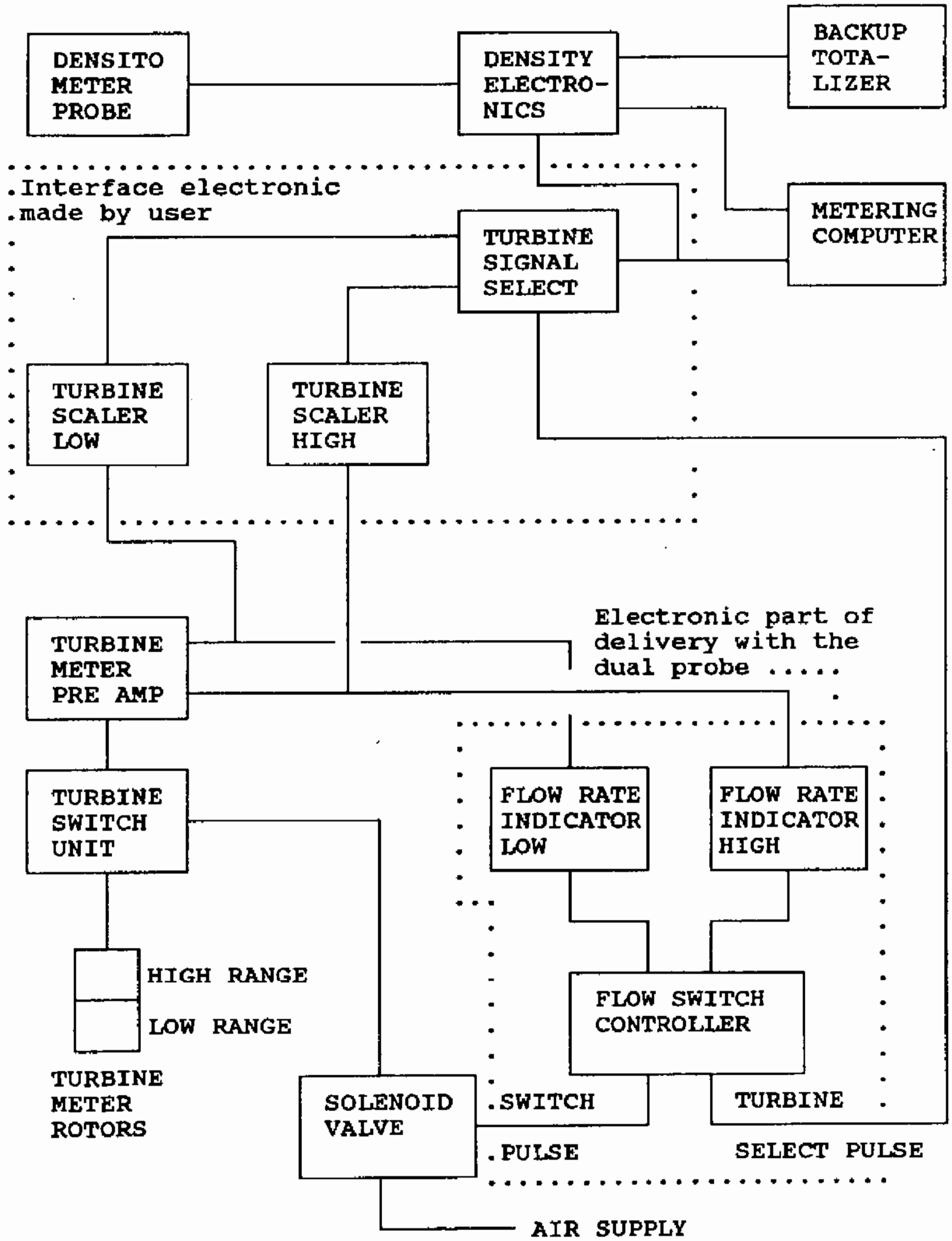

Figure 4 Principle interfase of dual flare probe

PRINCIPLE OF OPERATION

Initially when the dual flare probe is powered up, the probe will be in the high flow position. Under normal condition (low flow flaring of gas), the High Flow Rate Indicator will sense that the flow rate is too low and the low flow detector will trip. When the detector trips, the Flow Switch Controller will send a switching pulse to the solenoid valve which turns the probe to the low flow rotor position.

At the same time the Flow Switch Controller will send a turbine select pulse to the Turbine Signal Selector. The function of this selector is to send the turbine signal from the turbine in use to the Metering Computer and the Backup Totalizer.
Using the two Turbine Scaler units makes it possible to scale the signal from the two turbines to eliminate the difference in the meter factors, so that the meter factor to be used for the computer and the totalizer is identical for both rotors.

If the flow rate exceeds the high limit set in the Low Flow Rate Indicator, the sequence described above will be repeated and turn the probe to the high flow rotor position.

As indicated in figure 4 both the Turbine Scaler and the Turbine Signal Selector are made by the user. This was necessary in order to interface the dual flare probe to the original metering system. The old electronic and metering computer can only handle a sigle flare turbine meter signal.

EXPERIENCE WITH THE DUAL PROBE

The rotor in the original single turbine rotor system was selected based on a compromise between the low gas flaring under normal operation and the very high flare rate during a shut down situation. This compromise resulted in less accurate measurement in the low end and very often overranging of the turbine in the high end. A shut down of the platform also often resulted in a damaged turbine rotor.
The gas that is flared during a shut down period, represents a big part of the total gas that is burnt during a month. A metering system that could fail during the most important periods, was not satisfactory.

The dual rotor probe has greatly improved the system. The two rotors are selected so that one is sensitive enough to handle the low end and the other strong enough to withstand the high velocity of the flare gas during a shut down.
The increased range of the two turbines has resulted in more accurate metering both in the low and the high end.
The mechanical stronger high range turbine has also induced less maintenance on damaged turbines from a shut down.

The switching system has proven itself to be fast enough to handle a sudden change in flare gas flow rate.
In the beginning we had some problems with the switching mechanism due to mis-alignment of the mechanical linkage. This mis-alignment caused the linkage to be blocked in the low flow position, resulting in no measured gas above the switching point of the low range turbine. This often led to damaged low range turbine.
We have corrected this problem by a modification of the switching mechanic system. A guiding ring secure that the probe always stops in the correct position and also prevent mis- alignment of the linkage.
After thsi modification the dual flare turbine probe has been performing to our satisfaction.

DUAL FLARE PROBE USED WITH A MODERN FLOW COMPUTER

A suggestion of how to connect a dual flare turbine probe to a modern flow computer is given in figure 5.

The Flow computer may as a minimum have the following possibility:

1 System for automatic selection of either low or high turbine signal,
The pulses from the selected turbine is used in the flow calculation.

2 Ability to set a hysteresis band for the switching.

3 From the switching point, operate a relay contact for turning of the dual probe.

4 A check to ensure that pulses are accepted from just one turbine at the time.

5 Accept a frequency signal from a densitometer and calculate the density necessary for mass calculation of the flow.

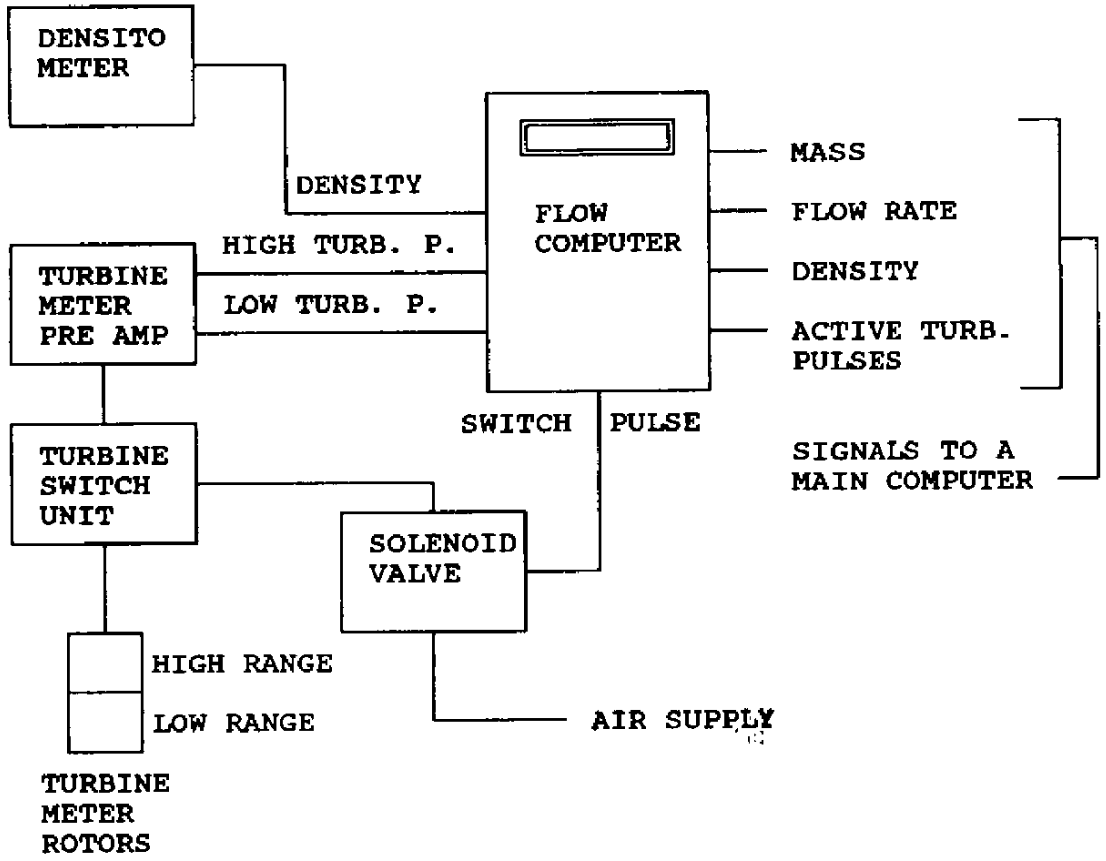

Figure 5 Dual flare probe connected to a Flow Computer

References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.