# COMPONENTS FOR A NEW TYPE CONTINUOUSLY MEASURING VISCOMETER

In proces industries and oil refineries viscosity is a quantity often measured continuously. The in-line instruments commercially available are based on different operating principles, such as:

a. The pressure drop across a capillary tube. The sample is pumped through the tube at constant flow rate. The pressure drop is a linear function of absolute viscosity (centi poise).

b. A drag torque between a stationary and a rotating element. The sample is sheared between both elements, thus causing a torque as a measure for viscosity.

Some other principles, like the timed fall of a defined object in the sample, are also in use, but they are less applicable for continuously measuring viscometers.

In order to compare the new viscometer with existing types, a well-known in-line instrument, based on the first principle, is described in some detail. Fig. 1 shows the schematic flow diagram.

The externally mounted filter provides a filtered sample to the instrument. As an extra safeguard against contaminants, a screen filter is provided at the sample inlet. A high precision metering pump, driven by a synchronous motor causes a constant sample flow, passing next through a heat exchanger. Because viscosity of liquids is generally highly dependent on temperature, both the pump and heat exchanger as well as the capillary tube are immersed in an oil bath of which the temperature is regulated to $\pm$ 0.005$^{\circ}$C.
The sample flow, now at constant rate and temperature is forced through the capillary tube and the pressure drop across this tube, converted into a pneumatic (3 - 15 psi) or electrical signal, is finally the measure for viscosity according to the Hagen-Poiseuille law.
Another screen filter in front of the capillary tube is provided to protect the capillary against coke particles that might form in the heat exchanger. A relief valve protects the system against any excessive pressure that might occur.

Fig. 2 shows the schematic flow diagram of the new viscometer. A process sample enters the instrument via a filter. A gear pump then forces a sample flow through a heat exchanger and via another filter to a pressure regulator and a turbine (rotor), which actually is the basic new element.

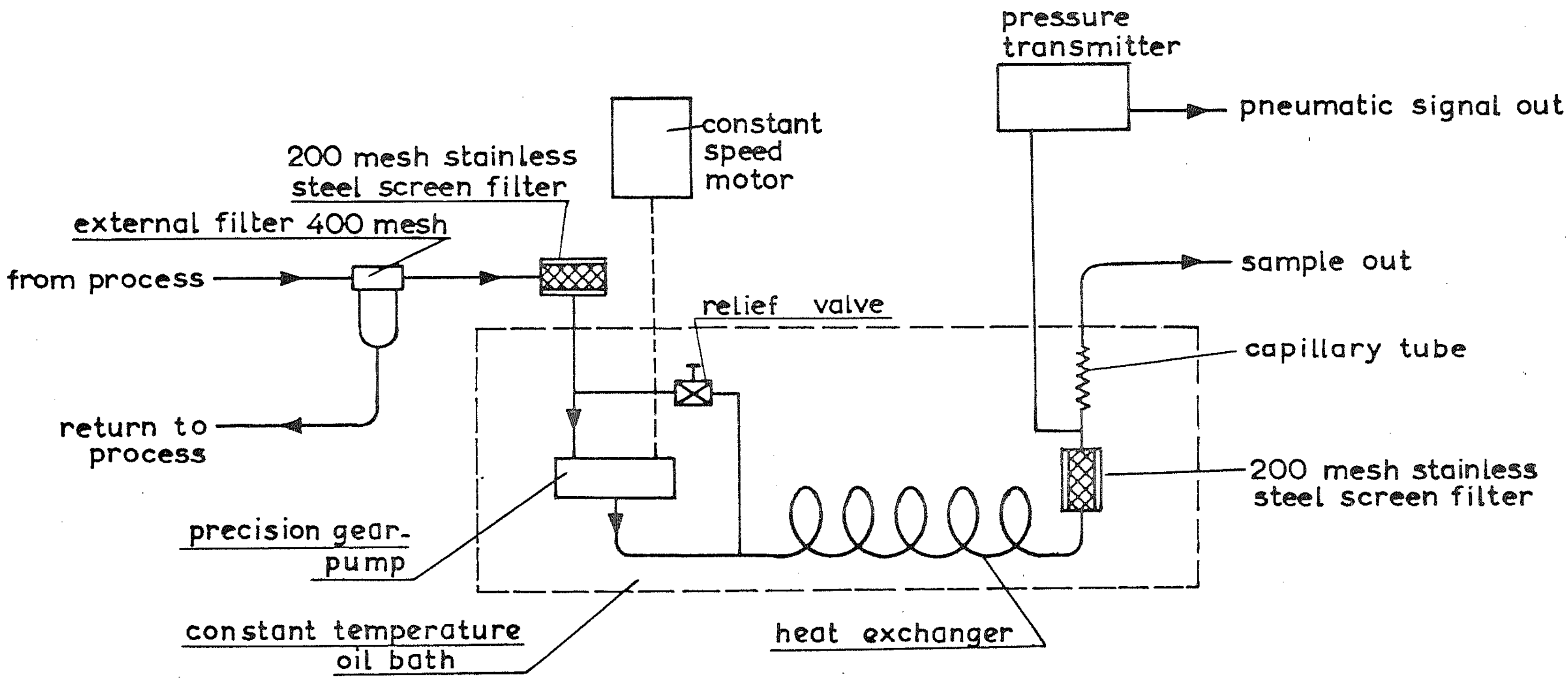


Fig. 1 Schematic flow diagram of capillary viscometer.

The essential property of this turbine (fig. 3) is that the time per revolution of its rotor is proportional to viscosity and inversely proportional to feeding pressure, which explains the presence of the pressure regulator. The pressure controlled by the regulator, is proportional to the weight of a freely floating body (fig. 4). Naturally, the temperature controlled oil bath in which the pump, heat exchanger, pressure regulator and turbine are immersed should be applied as in the conventional meters.

Compared with the capillary type meter the new viscometer has the following features:

1. A direct digital output, i.e. pulses counting the turbine rotor revolutions or part thereof.
2. No need for a precision metering pump, since the applied simple gear pump may have back leakage. Instead of a constant flow rate, the pressure over the turbine has to be regulated, which is done by the pressure regulator.
3. The sample fluid does not need to have lubricating properties, because the floating body in the pressure regulator as well as the turbine rotor are self centering and the mating surfaces are completely separated by a fluid film. Also the simple gear pump can do without lubrication.
4. Blockage of components is unlikely to happen, thanks to spacious clearances in the gear pump, pressure regulator and turbine. Therefore, filters with comparatively wide mesh sizes may be applied.

Conclusion:

A viscometer built with the new components may be expected to be more reliable in operation and less expensive to produce.

Note on further research:

The turbine rotor is now being developed for use as a differential pressure transducer. Applications may well compete with existing $\Delta$ P cells.

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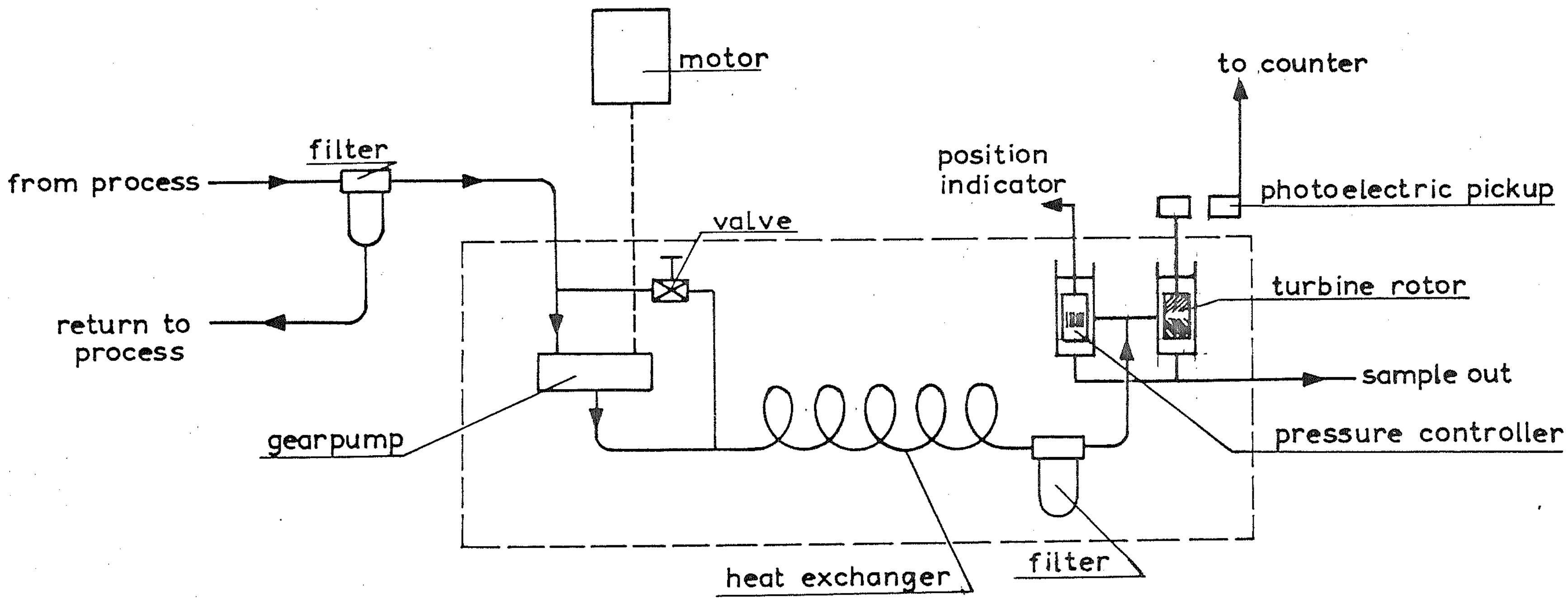


Fig. 2 Schematic flow diagram of new viscometer.

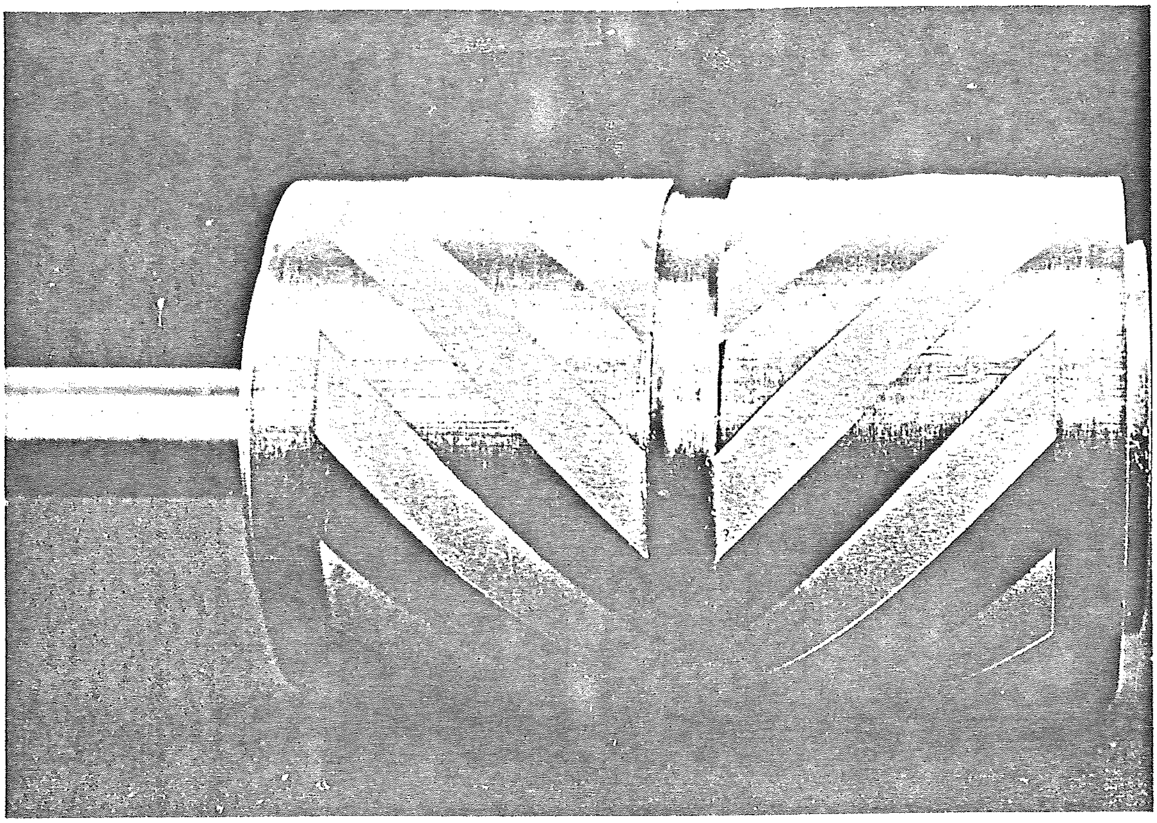

Fig. 3 - Turbine rotor

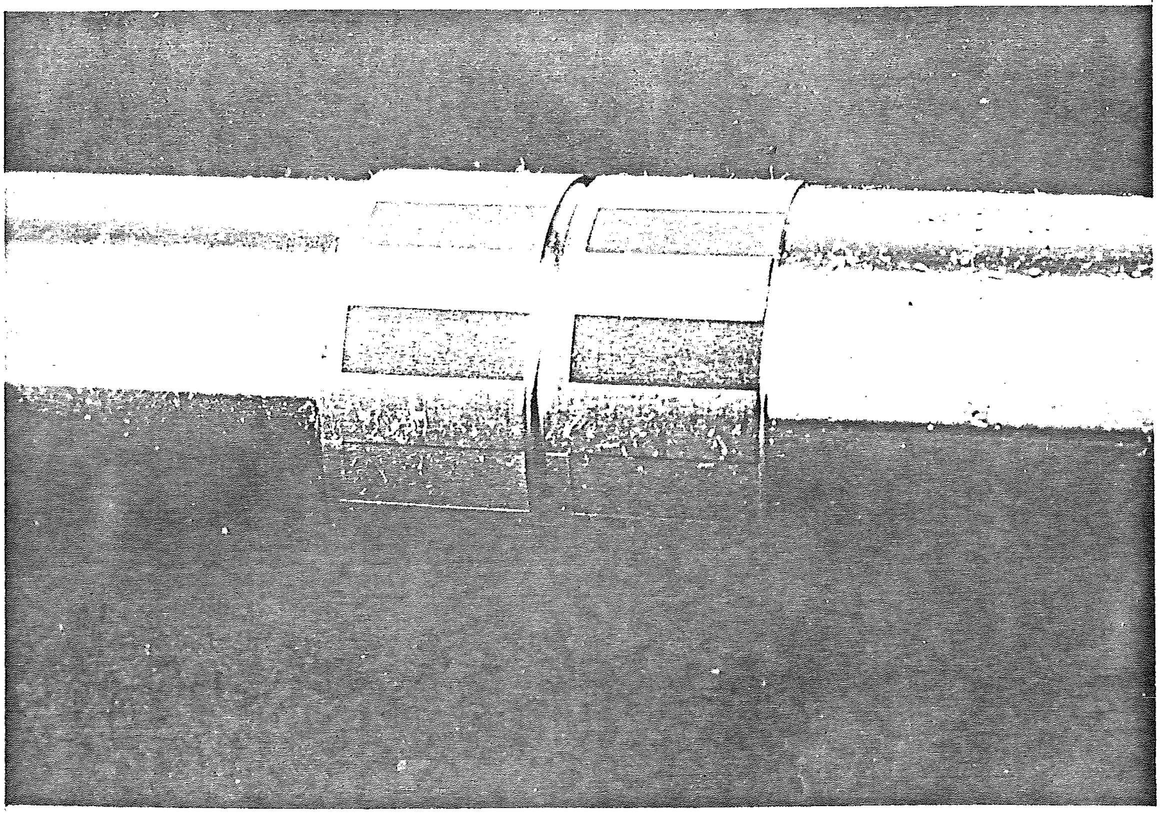

Fig. 4 - Pressure controller