8. SPECIALISED FLOWMETERS 2.

8.5. Coriolis flowmeters

8.5.1. Application example: chemical industry

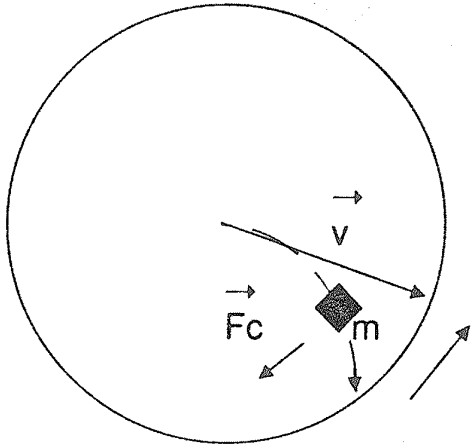
8.5.2. Principle and layouts

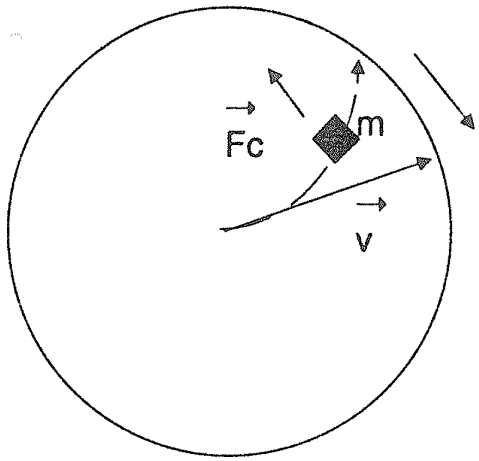
$$\underline{F}_C = m \cdot 2\underline{v} \times \underline{\omega}$$

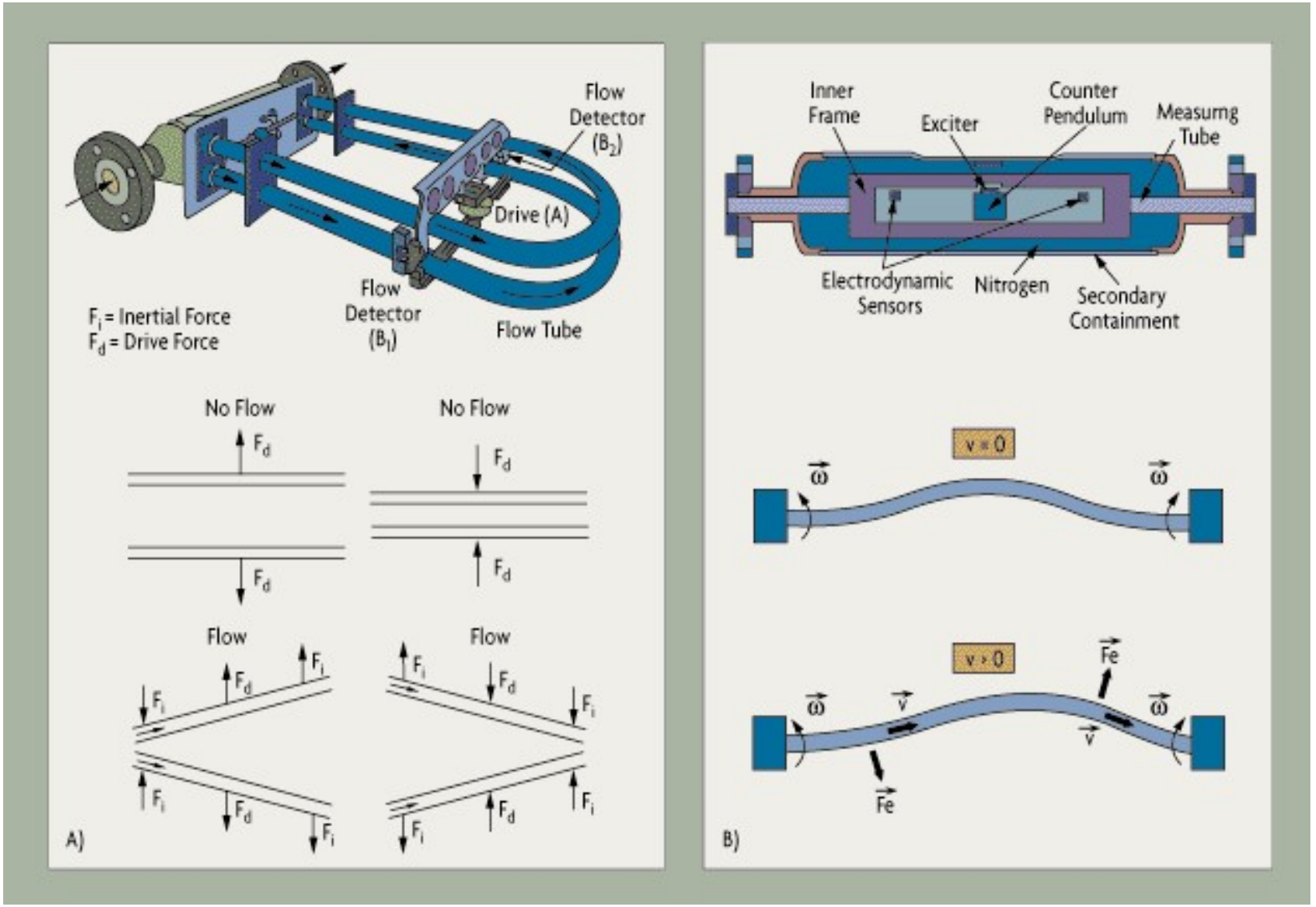
$$m \sim \rho A$$

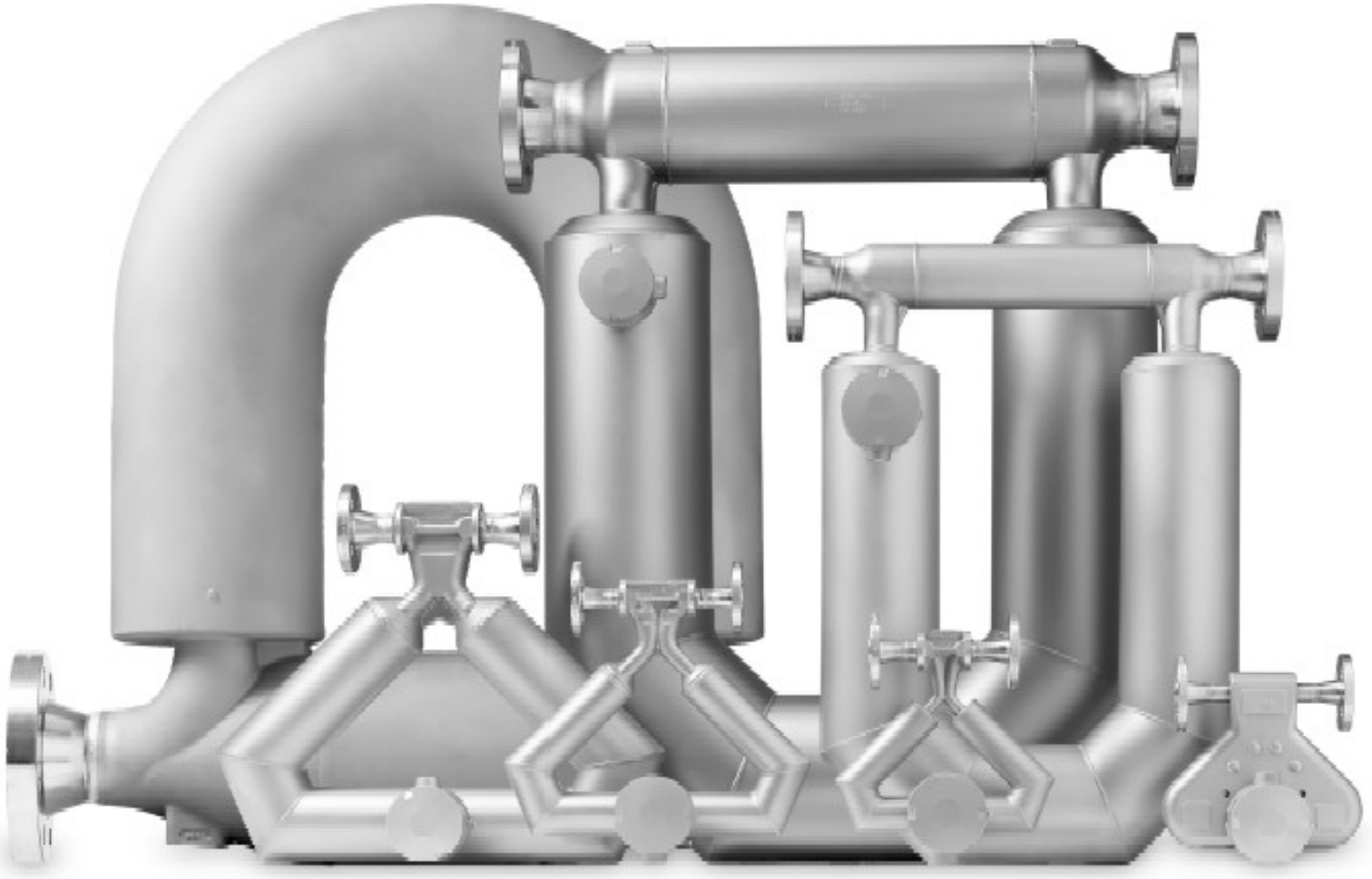
$$\underline{F}_C \sim \rho A \underline{v} \times \underline{\omega}$$

$$\left|\underline{F}_C\right| \sim q_m \omega$$






Flow Detector (B_2)
Drive (A)
Flow Detector (B_1)
Flow Tube
F_i = Inertial Force
F_d = Drive Force
No Flow
No Flow
Flow
Flow
A)
Inner Frame
Exciter
Counter Pendulum
Measurng Tube
Electrodynamic Sensors
Nitrogen
Secondary Containment
v = 0
v > 0
B)



Advantages of the U-type (or Delta-type) arrangement:

•Increased pipe deformation $\Rightarrow$ measurement

Limitations / disadvantages:

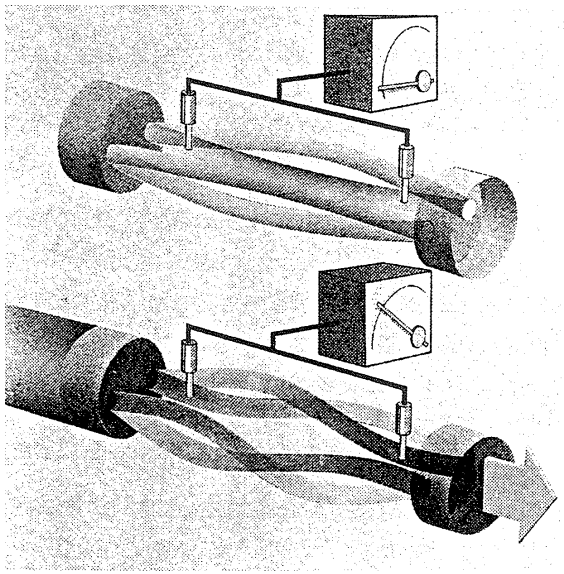
•Low eigenfrequency (cca. 100 Hz)

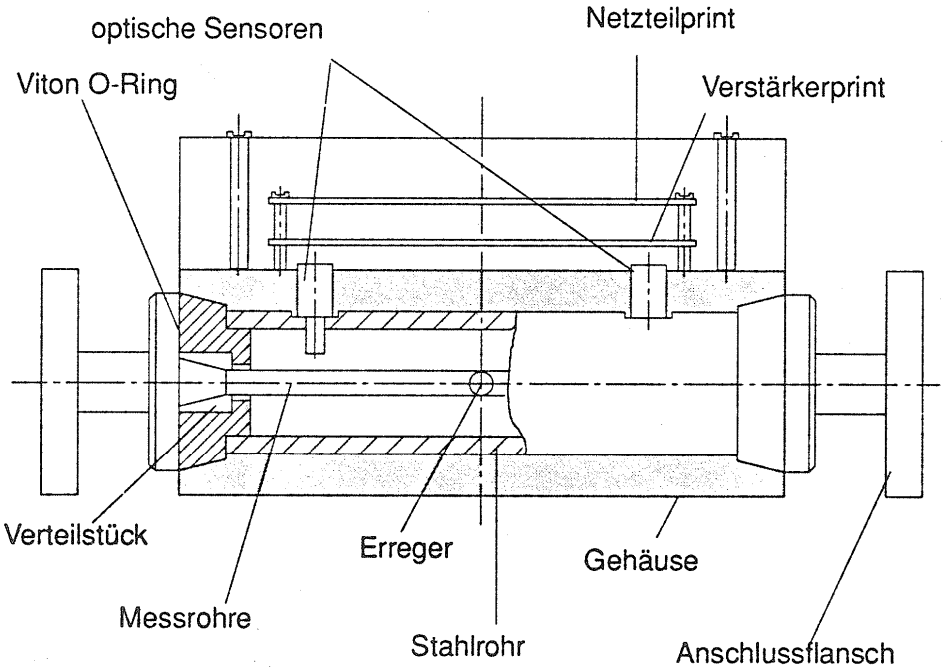
•Limited temporal resolution

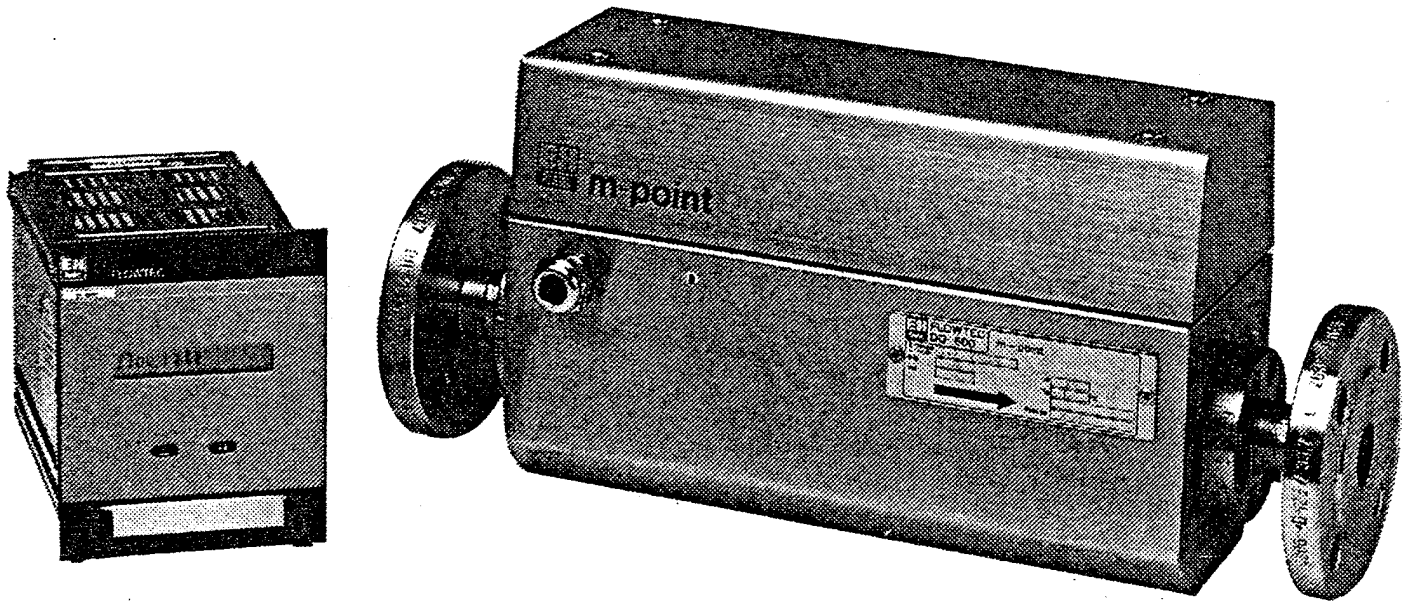
•Increased space demand

•Increased pressure drop

•Limited viscosity




optische Sensoren
Netzteilprint
Viton O-Ring
Verstärkerprint
Verteilstück
Erreger
Gehäuse
Messrohre
Stahlrohr
Anschlussflansch


m-point

ADVANTAGES:

- Direct measurement of mass flow rate
- Measurement of fluid density
- Simplified tube construction, limited space demand possible
- No dependence on fluid viscosity
- Multiphase flows can be measured within limits
- No dependence on the velocity profile
- High accuracy (o.m. of 1 % uncertainty in mass flow rate)

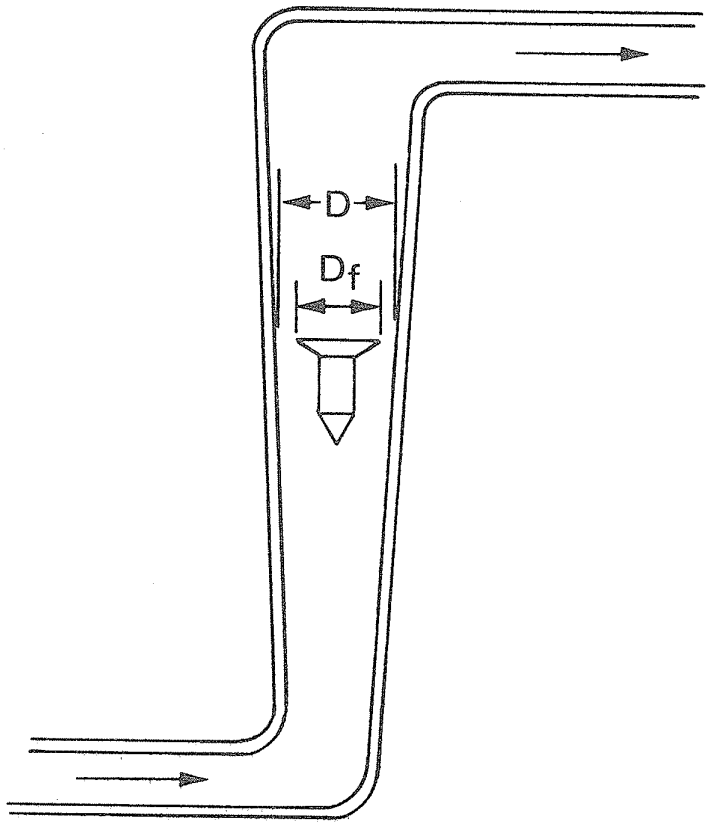
LIMITATIONS / DISADVANTAGES:

- Liquids (?)
- Relatively expensive
- Vibration-sensitivity $\Leftrightarrow$ increase of costs
- Gas bubbles $\Rightarrow$ attenuate the vibration
- No measurement is possible at presence of gas corks
- Solid particles: abrasion of the tube
- Risk of cavitation
- No measurement: partial fill-up
- No higher temperatures

8.6. Variable area flowmeters

8.6.1. Application examples: rapid flow tests by visual inspection

8.6.2. Principle and layout



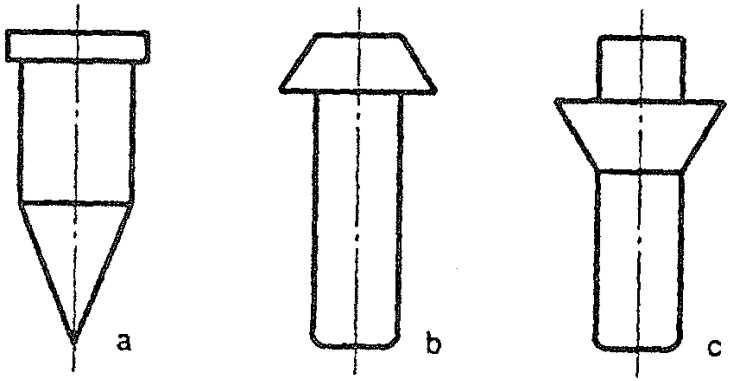
$$F_W = g\left(\rho_{float} - \rho_{fluid}\right)V_{float}$$

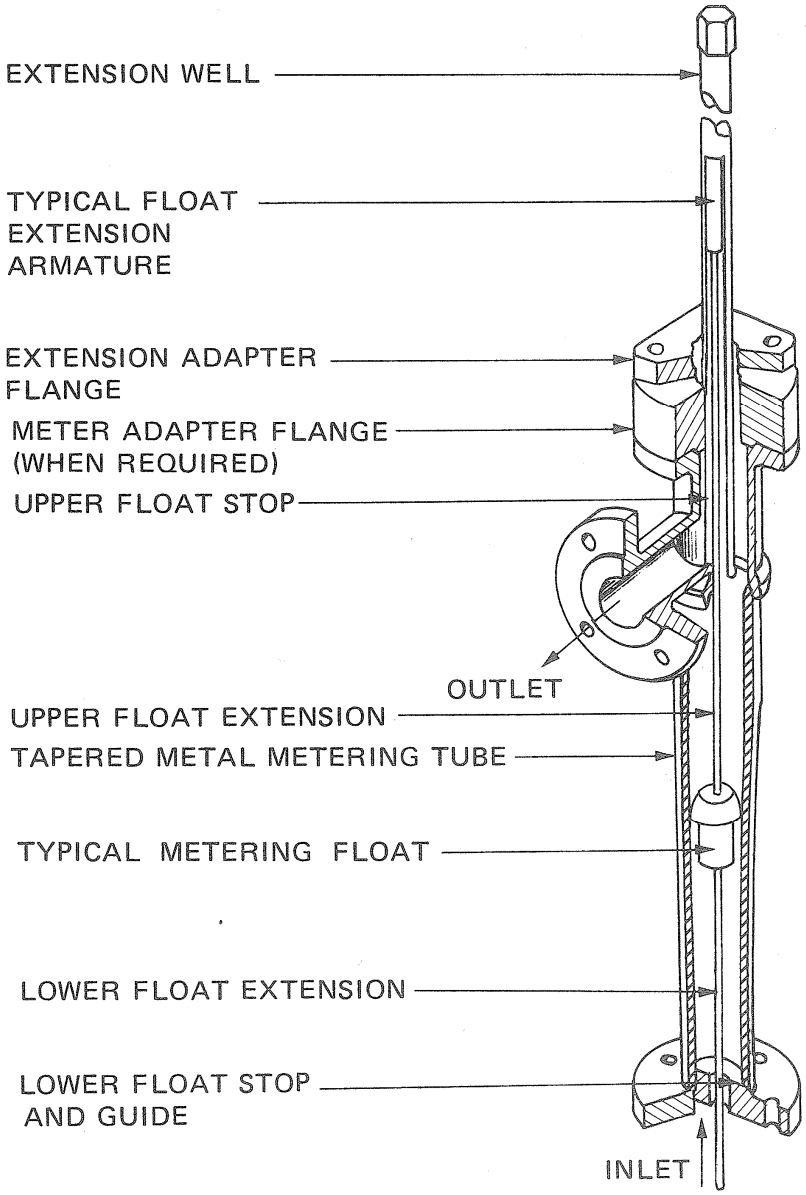
$$F_D = C_{D\,float} A_{float} \rho_{fluid} \frac{v^2}{2}$$

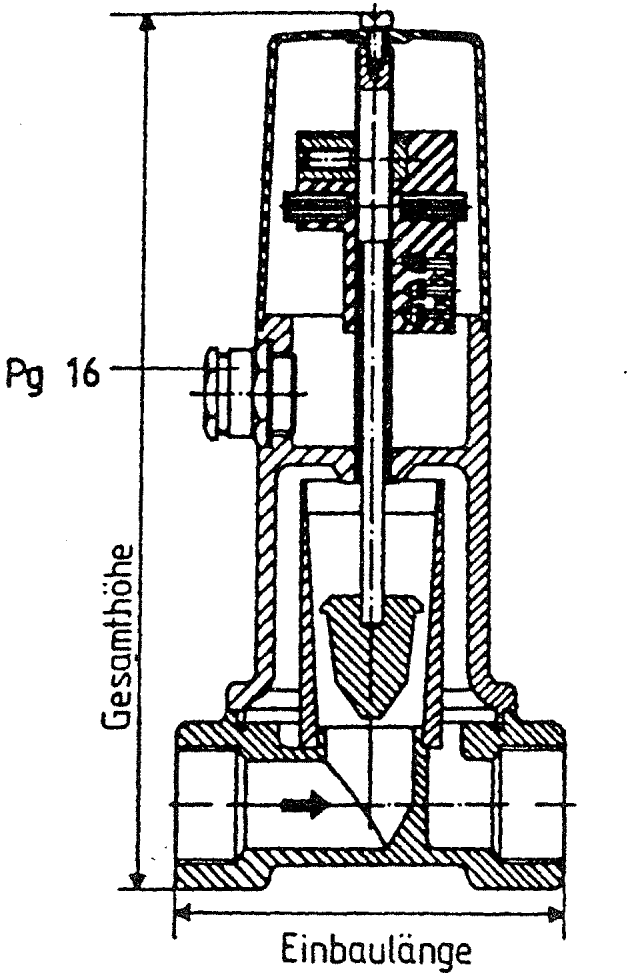
$$= C_{D\,float} A_{float} \rho_{fluid} \frac{1}{2}\left(\frac{q_V}{A}\right)^2$$

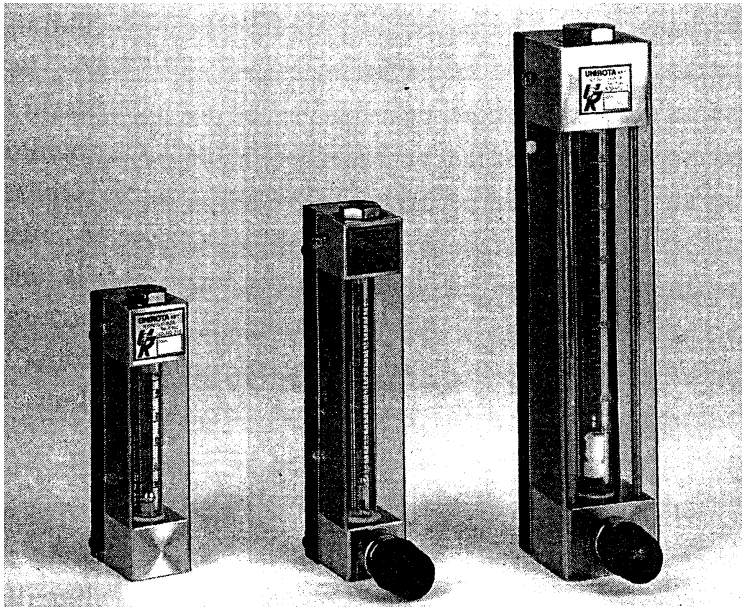
$$F_W = F_D$$

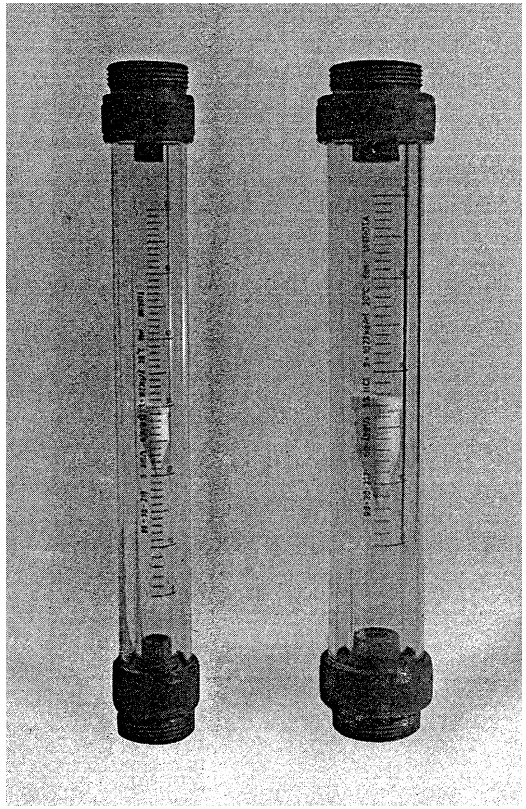
$$q_V = \left[A \frac{1}{\sqrt{C_{D\ float}}} \right] \cdot \sqrt{\frac{2gV_{float}}{A_{float}}} \cdot \sqrt{\frac{\rho_{float} - \rho_{fluid}}{\rho_{fluid}}}$$

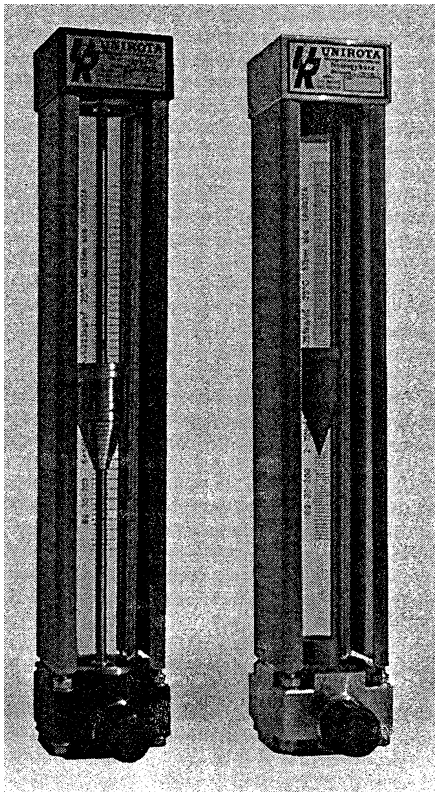


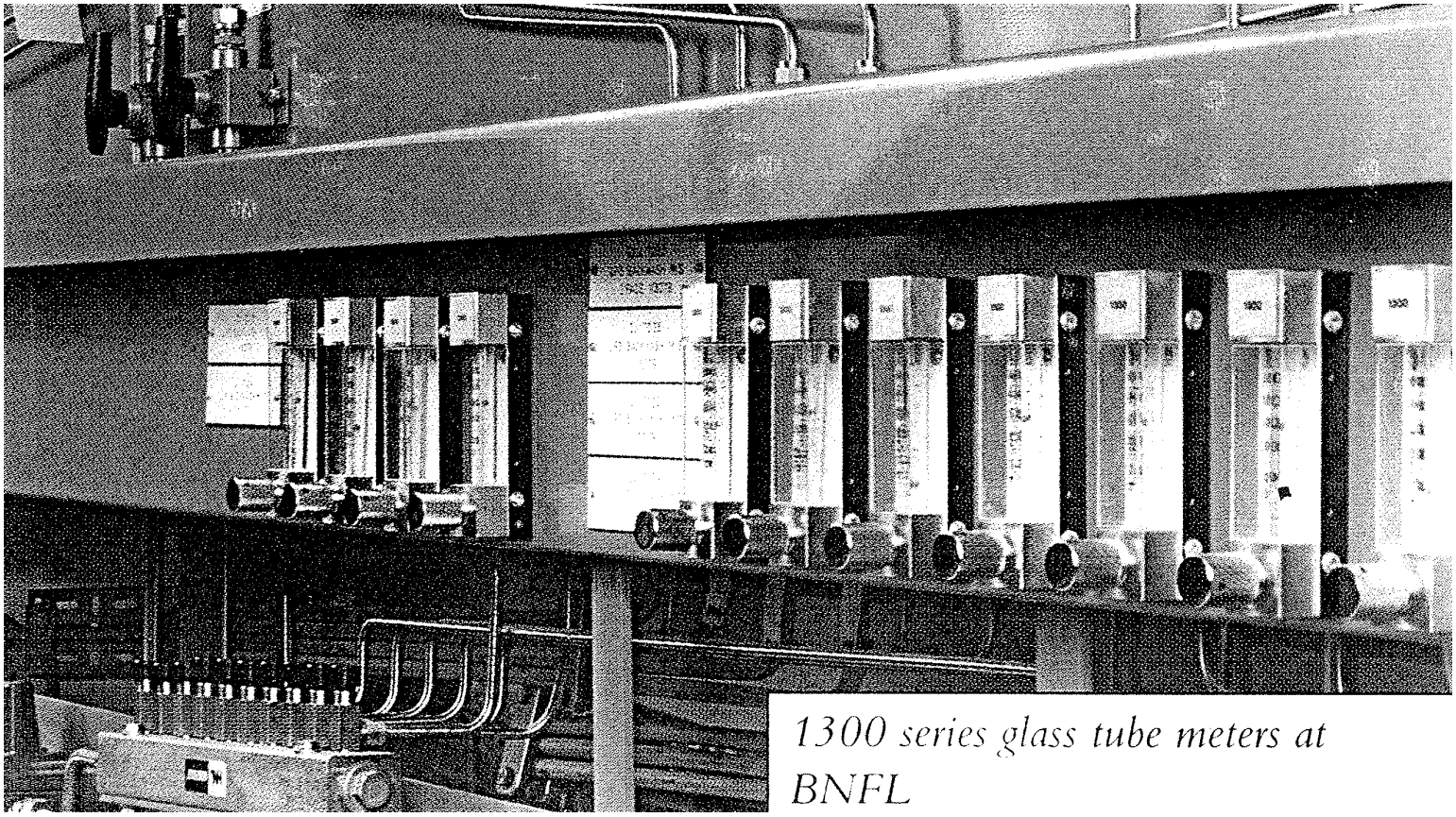

EXTENSION WELL
TYPICAL FLOAT
EXTENSION
ARMATURE
EXTENSION ADAPTER
FLANGE
METER ADAPTER FLANGE
(WHEN REQUIRED)
UPPER FLOAT STOP
OUTLET
UPPER FLOAT EXTENSION
TAPERED METAL METERING TUBE
TYPICAL METERING FLOAT
LOWER FLOAT EXTENSION
LOWER FLOAT STOP
AND GUIDE
INLET


Pg 16
Gesamthöhe
Einbaulänge

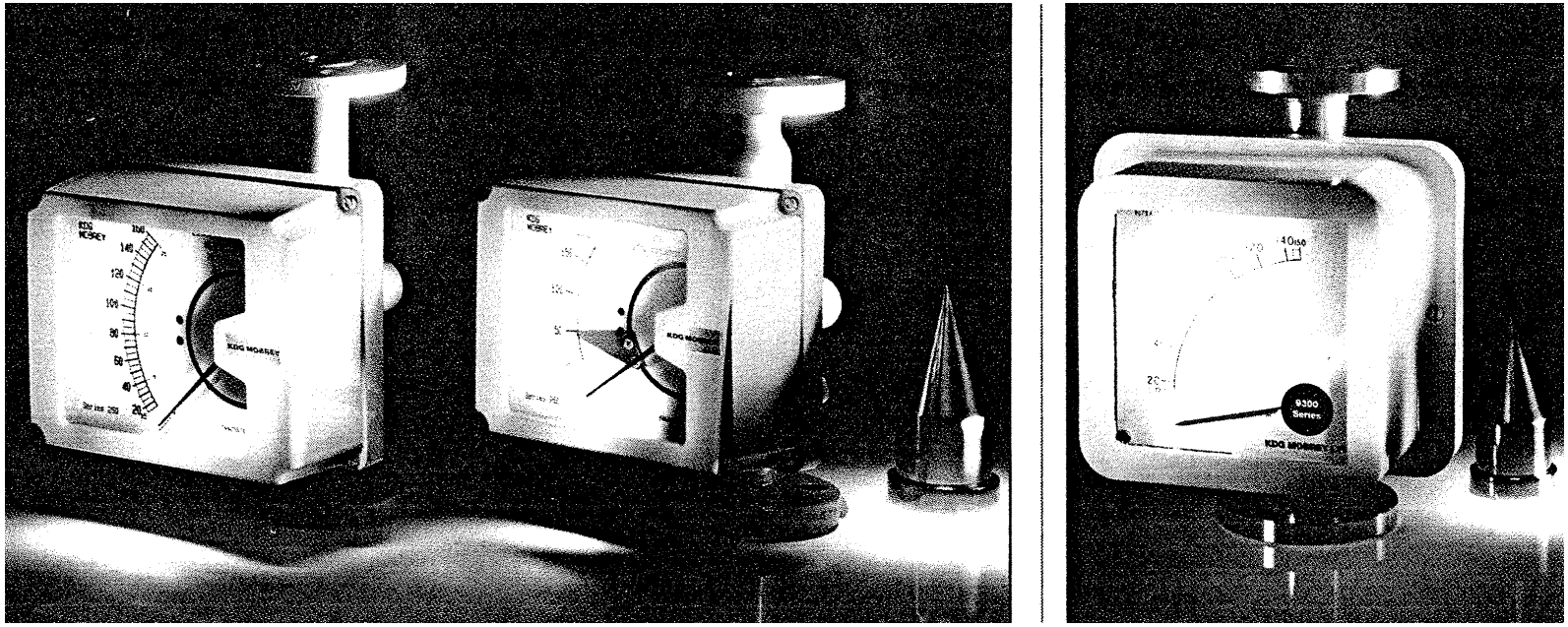


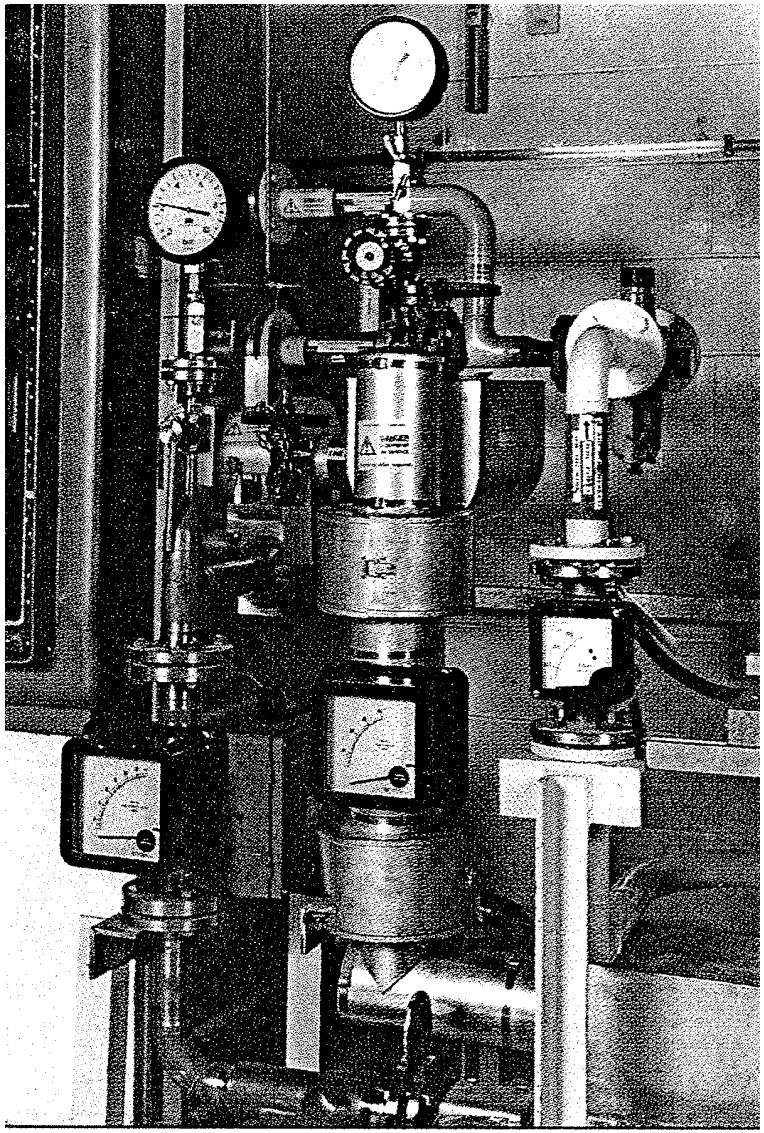






1300 series glass tube meters at BNFL


9300
Series



9300 Series metal tube meters at BNFL

ADVANTAGES:

•Limited expenses

•Simple layout, installation and operation

•Interchangeable float $\Rightarrow$ extension of flow rate range

•Transmittability $\Rightarrow$ no clogging

•Robustness

LIMITATIONS / DISADVANTAGES:

•Limited viscosity fluids

•Lower limit of measurements

•Dependence of the measurement on the fluid density (temperature, pressure, specific gas constant) + Reynolds number effect

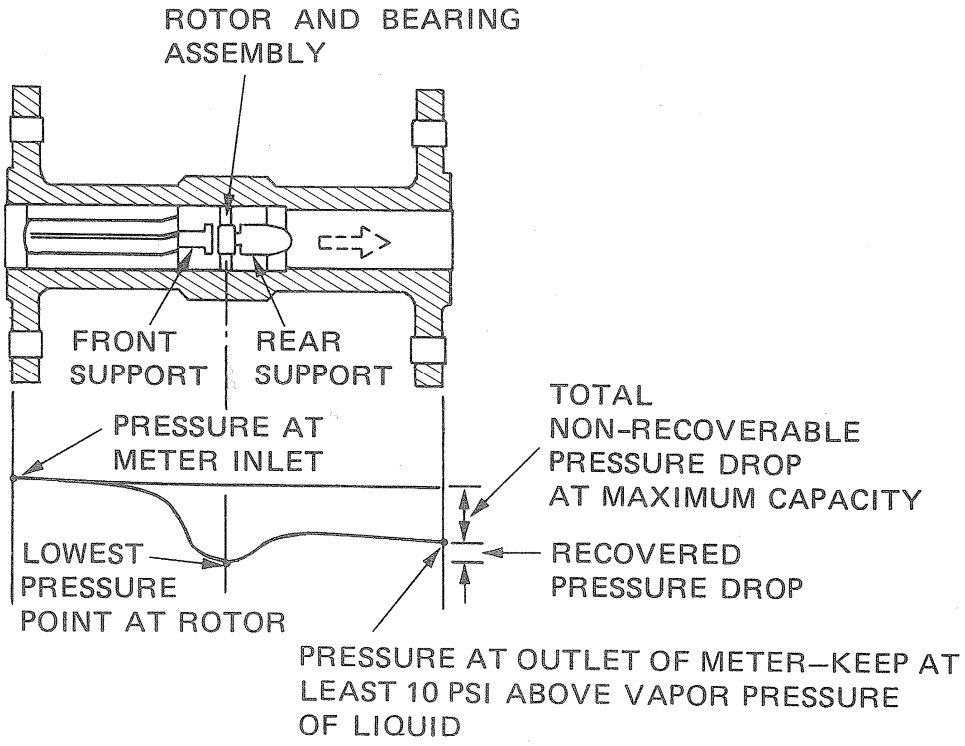
•Limited accuracy

•Disturbance by another phase

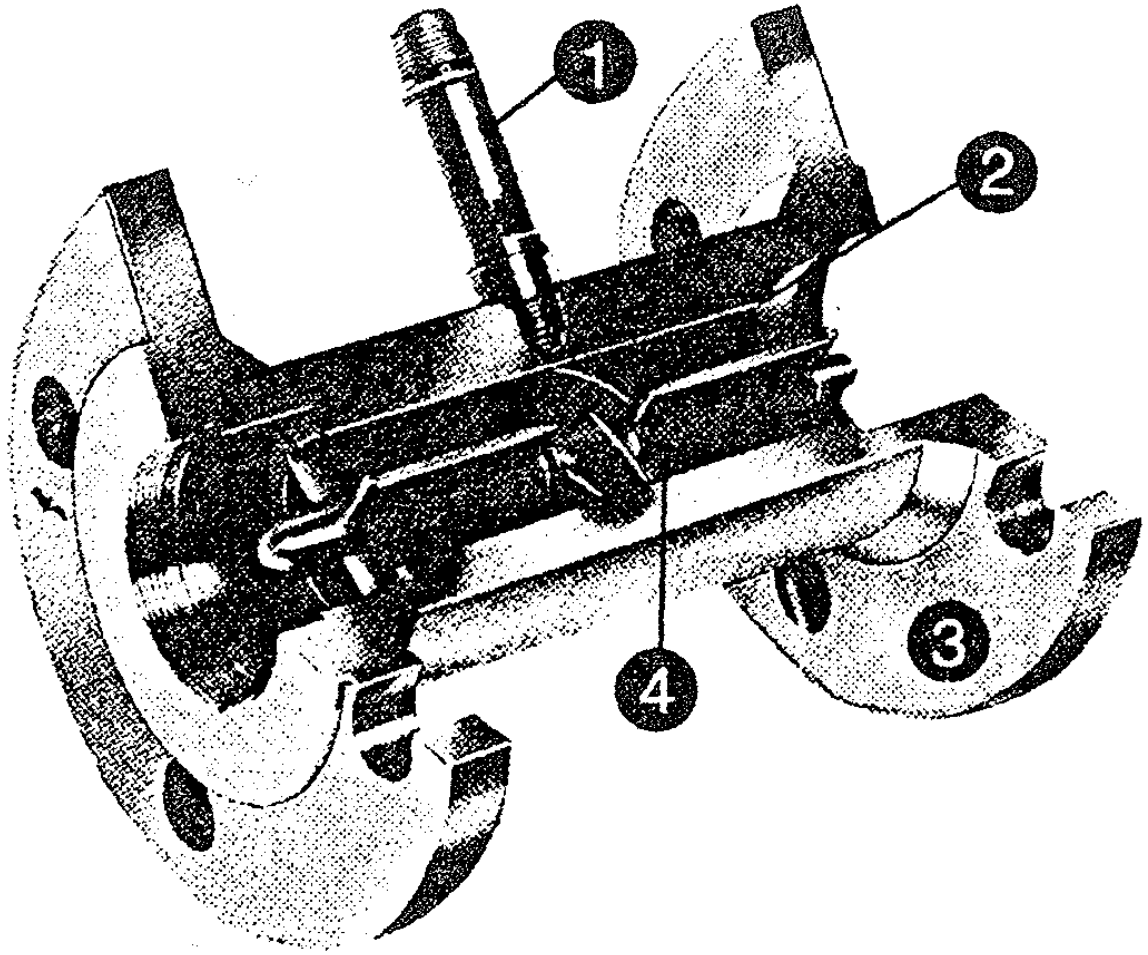
8.7. Turbine flowmeters

8.7.1. Application example: petrochemical products

8.7.2. Principle



$$v = 2\,r\,\pi\,n\,ctg\,\alpha$$


1
2
3
4

ADVANTAGES:

•High accuracy for specified viscosity
•Wide temperature domain, limited by mechanics and thermal dilation
•Up to high system pressures
•Suitable for electrically insulating fluids
•Wide range of measurable volume flow rate

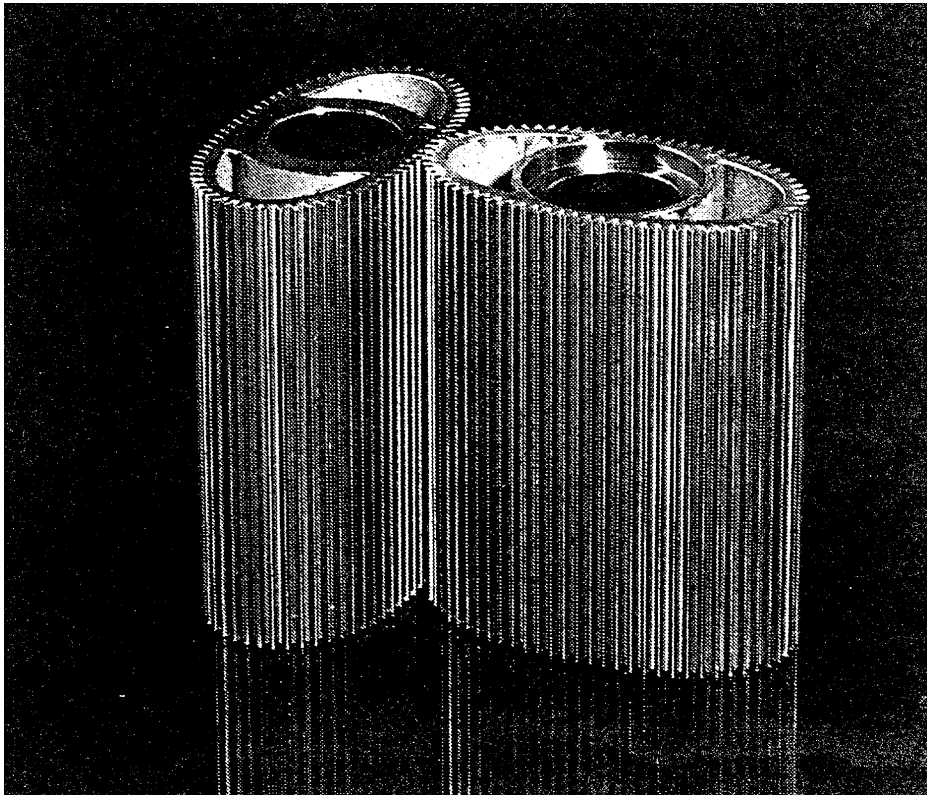
LIMITATIONS / DISADVANTAGES:

•The viscosity is to be known
•Undisturbed straight pipe sections
•Not applicable in swirling flows
•No fluids laden with solid particles
•Ambient vibration is to be avoided
•The approved measurement range is not to be exceeded
Relatively high pressure drop

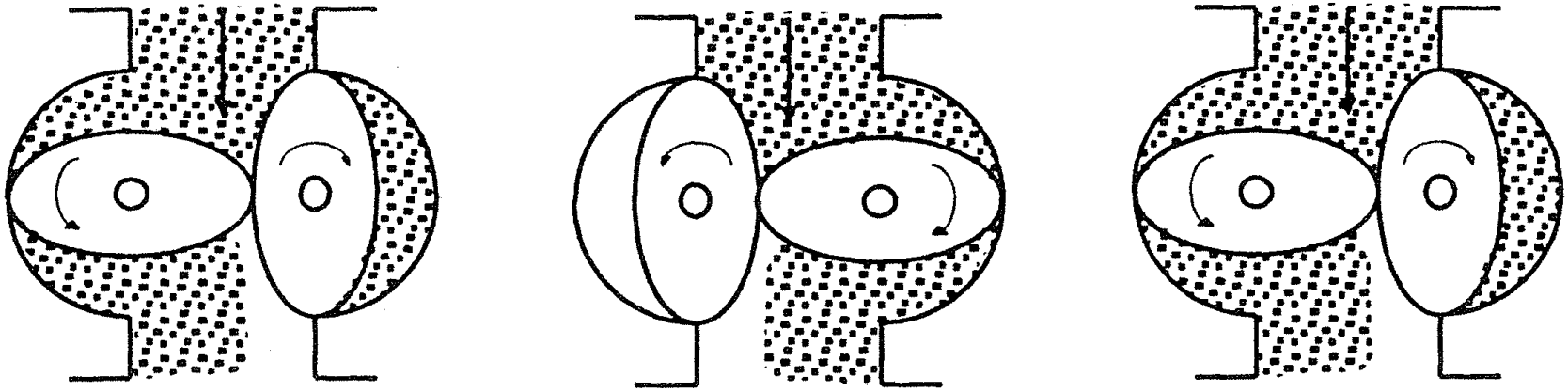
8.8. Volumetric flowmeters

8.8.1. Application example: fine dosing

8.8.2. Principle and layouts – an example: oval cogwheel meter



Oval cogwheels



ADVANTAGES:

- High accuracy
- Very low flow rates / quantities can be measured
- No dependence of fluid viscosity over a wide range

LIMITATIONS / DISADVANTAGES:

- Costly investment
- Increased maintenance costs
- The life cycle is limited
- High pressure drop
- Sensitive to overload
- Clogs the pipe in the case of failure
- Not suitable for contaminated, aggressive fluids
- Not suitable for higher temperatures
- Not suitable for pulsing flow
- Sensitive to external vibration