Resources of FLUID MECHANICS Lab (CHE 320)

1) Reynold's Number

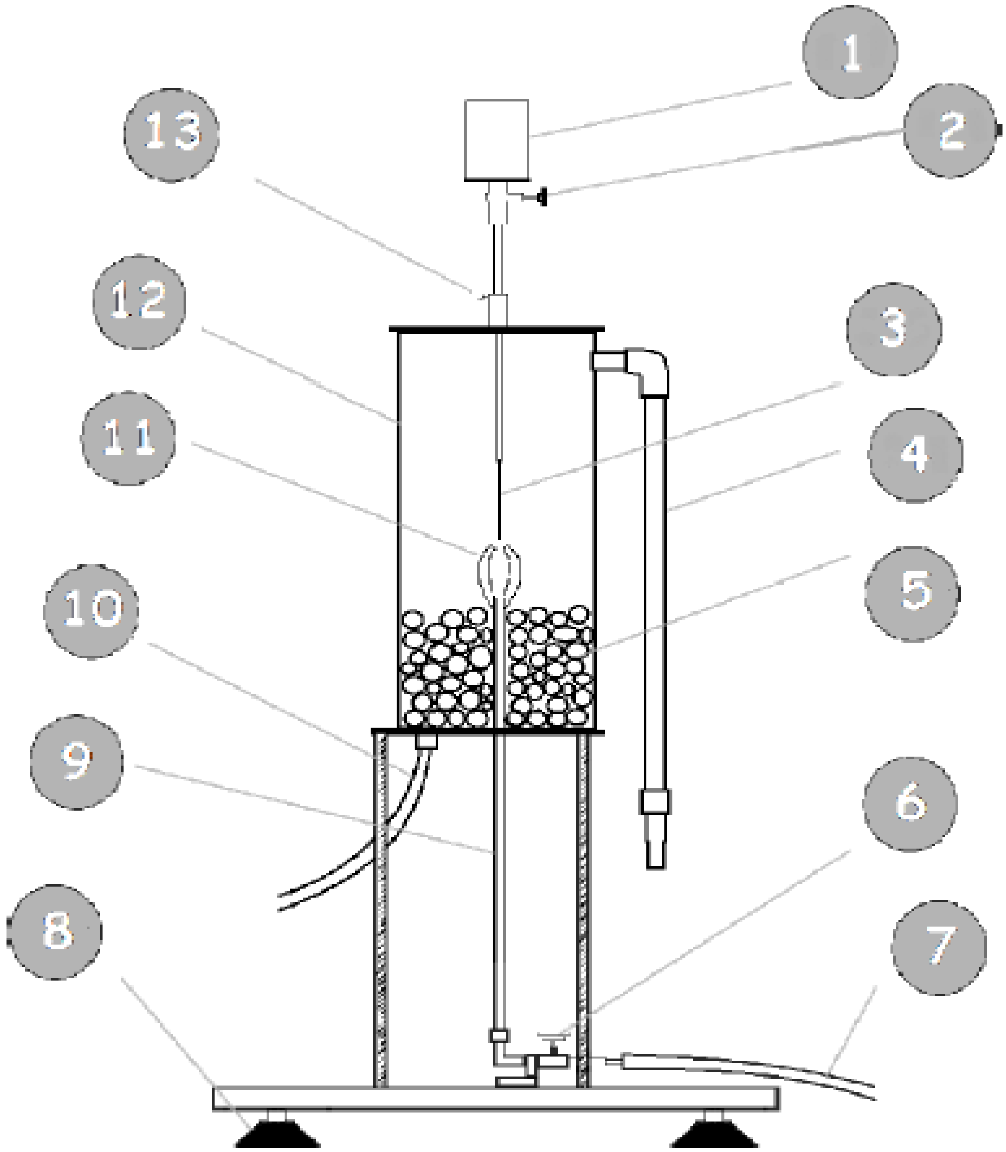


Fig 1: Reynold's Dye apparatus

Parts Identification

- 1) Dye reservoir
- 2) Dye flow control valve
- 3) Hypodermic tube
- 4) Overflow
- 5) Glass marbles

- **6) Flow control valve**
- **7) Outlet pipe**
- **8) Adjustable feet**
- **9) Test section (flow visualization pipe)**
- **10) Inlet pipe**
- **11) Bell mouth entry**
- **12) Head tank**
- **13) Height adjustment screw**

Description

The inlet pipe is used to supply water to the 'constant head tank'. The purpose of the glass marbles is to eliminate any turbulence from the inlet pipe flow. The flow visualization pipe is fitted with a bell mouth entrance to allow smooth entry into the pipe. Water flows through the test section with the flow rate being controlled by the 'flow control valve'. Once the desired flow has been established, dye is injected from the reservoir above in order to visualize the flow.

2) Orifice plate, venturi meter, Nozzle

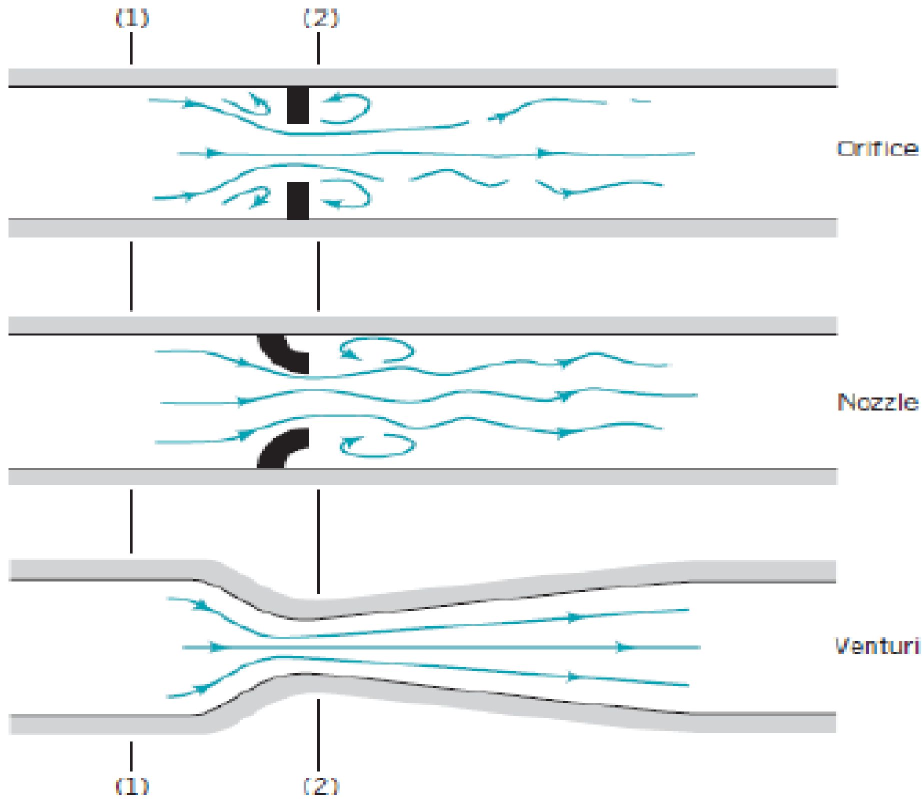


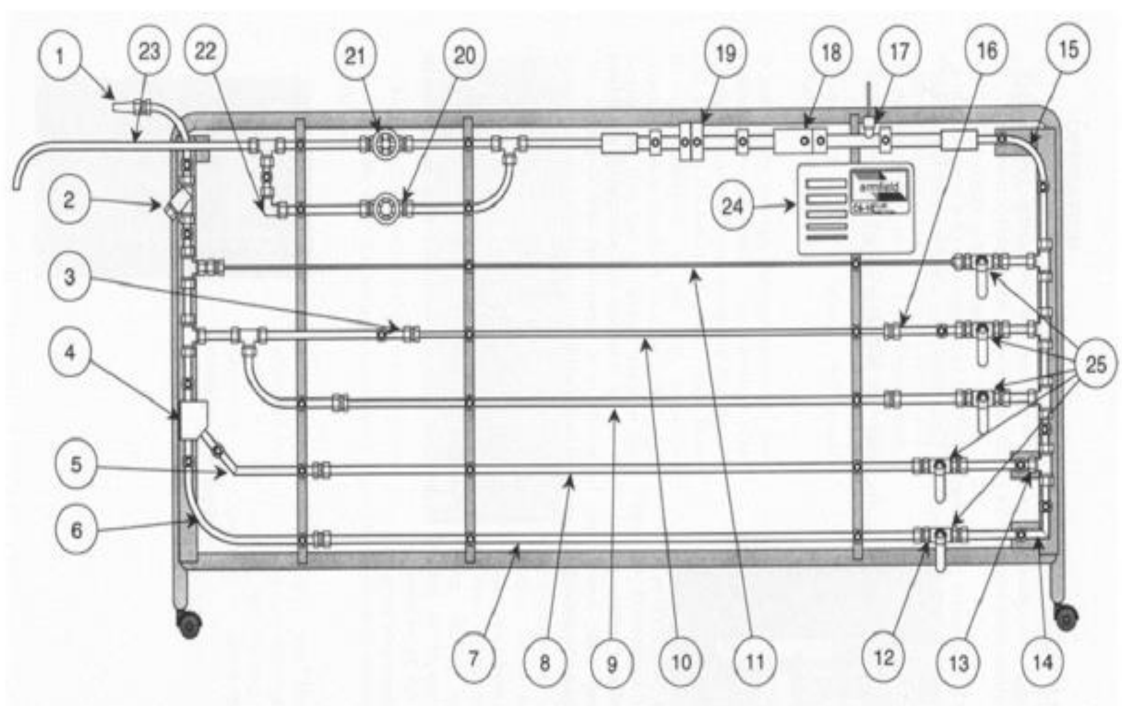
Fig 2: Orifice plate, venturi meter, Nozzle

Technical Description

An effective way to measure the flow rate through a pipe is to place some type of restriction within the pipe as shown in the figure, and to measure the pressure difference between the low-velocity, high- pressure upstream section, and the high- velocity, low-pressure downstream section. Three commonly used types of flow meters are shown in the figure: the ***orifice meter***, the ***nozzle meter***, and the ***Venturi meter***. The operation of each is based on the same physical principles — an increase in velocity causes a decrease in pressure. The difference between them is a matter of cost, accuracy, and how closely their actual operation obeys the idealized flow assumptions.

Another common type of flow meter is the ‘variable area flow meter’ (also known as ***rotameter***). In this device a float is contained within a tapered and transparent metering tube that is attached vertically to the pipeline. As fluid flows through the meter 1entering at the bottom, the float will rise within the tapered tube and reach an equilibrium height that is a function of the flow rate. This height corresponds to an equilibrium condition for which the net force on the float (buoyancy, float weight, fluid drag) is zero. A calibration scale in the tube provides the relationship between the float position and the flow rate.

3) **Equipment diagram for pipe friction apparatus**



Description

Apparatus and Setup:

This equipment does not require any special setup before the experiment. However, it should be ensured that the flow occurs only through the test pipe under observation. In this case there are different pipe sizes for each of which the data must be recorded. Before starting the experiment, the pipe network should be primed with water.

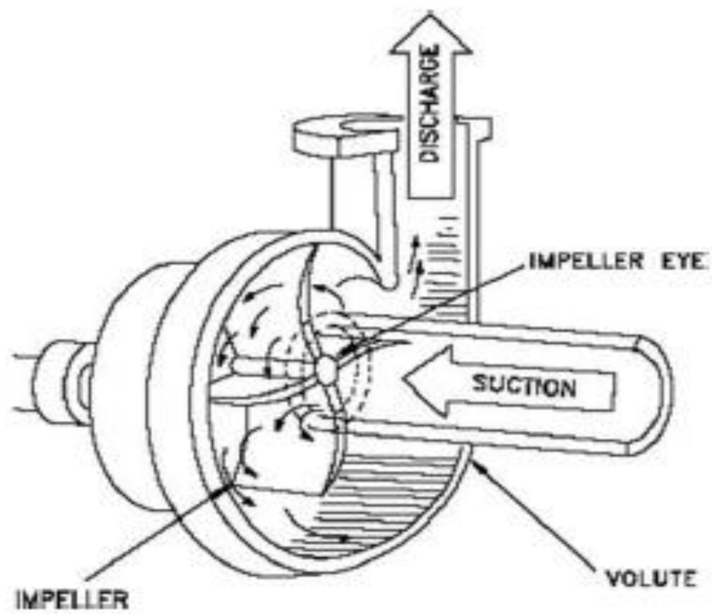
The test pipes and fittings are mounted on a tubular frame carried on castors. Water is fed in from the hydraulics bench via the barbed connector (1), flows through the network of pipes and fittings, and is fed back into the volumetric tank via the exit tube (23). The pipes are arranged to provide facilities for testing the following:

- • An in-line strainer (2)
- • An artificially roughened pipe (7)
- • Smooth bore pipes of 4 different diameters (8), (9), (10) and(11)
- • A long radius 90° bend (6)
- • A short radius 90° bend (15)
- • A 45° "Y" (4)
- • A 45° elbow (5)
- • A 90° "T" (13)
- • A 90° mitre (14)
- • A 90° elbow (22)
- • A sudden contraction (3)
- • A sudden enlargement (16)
- • A pipe section made of clear acrylic with a Pitot static tube (17)
- • A Venturi meter made of clear acrylic (18)
- • An orifice meter made of clear acrylic (19)
- • A ball valve (12)
- • A globe valve (20)
- • A gate valve (21)

Short samples of each size test pipe (24) are provided loose so that you can measure the exact diameter and determine the nature of the internal finish. The ratio of the diameter of the pipe to the distance of the pressure tappings from the ends of each pipe has been selected to minimize end and entry effects.

A system of isolating valves (25) is provided whereby the pipe to be tested can be selected without disconnecting or draining the system. The arrangement also allows tests to be conducted on parallel pipe configurations.

4) Centrifugal pump



Technical description:

Centrifugal pumps are commonly used in homes and industries and it is important for an engineer to know about the performance and selection of such pumps. In this type of pump the fluid is drawn into the center of a rotating impeller and is thrown outwards by centrifugal action. As a result of the high speed of rotation the liquid acquires high kinetic energy. The pressure difference between the suction side and the discharge side arises from the conversion of this kinetic energy into pressure. The centrifugal pump is a radial flow device.

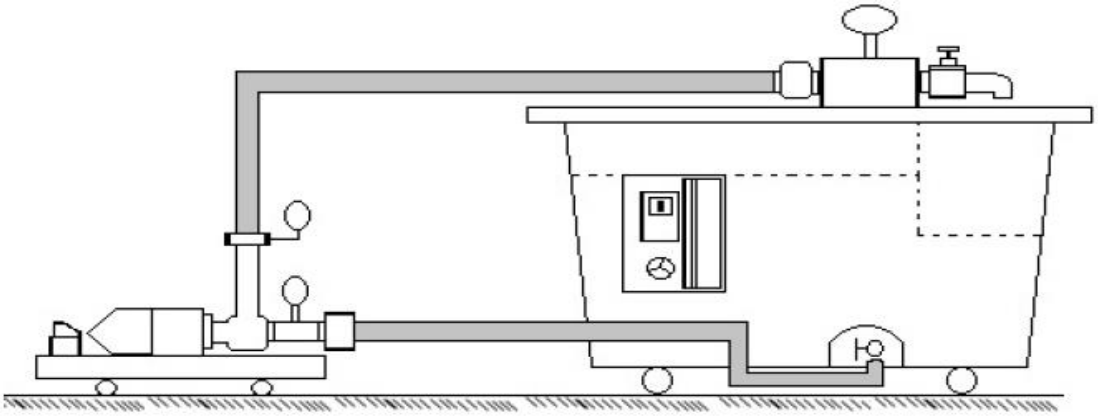


Figure 9: Single Pump Operation

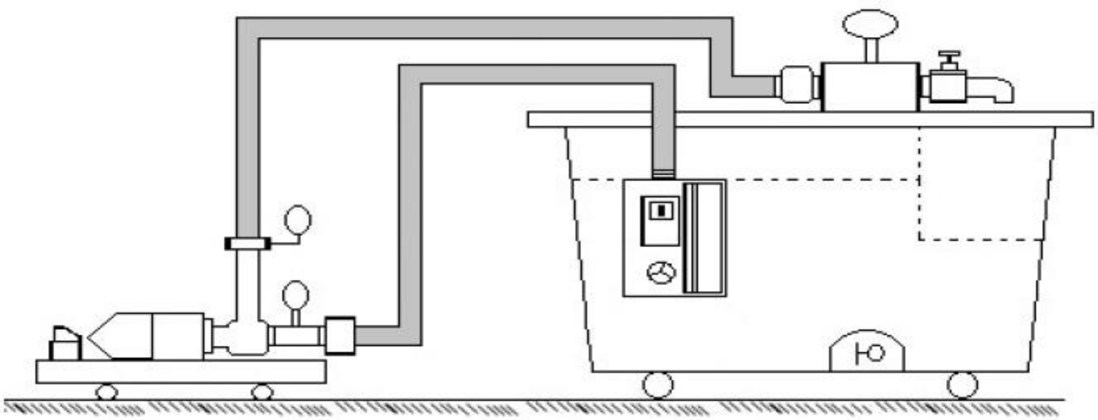


Figure 10: Series Pump Operation

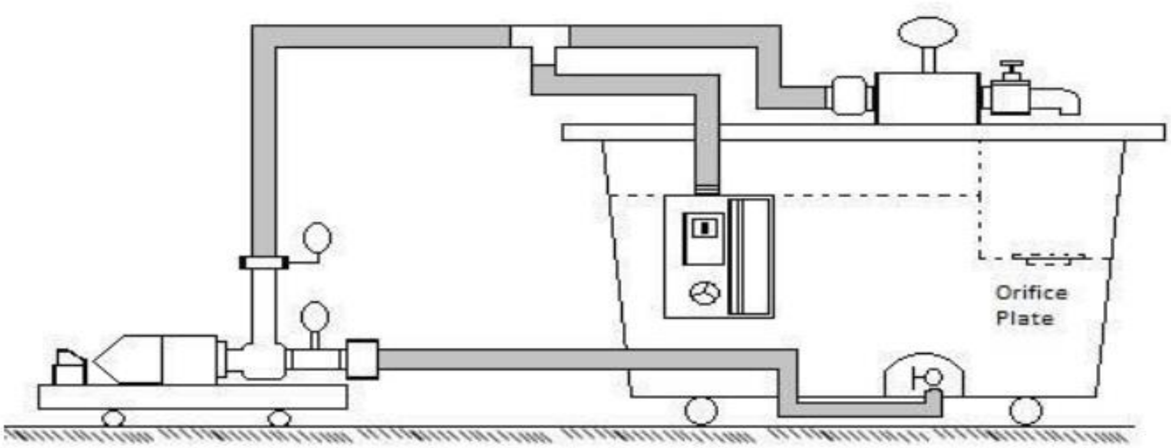
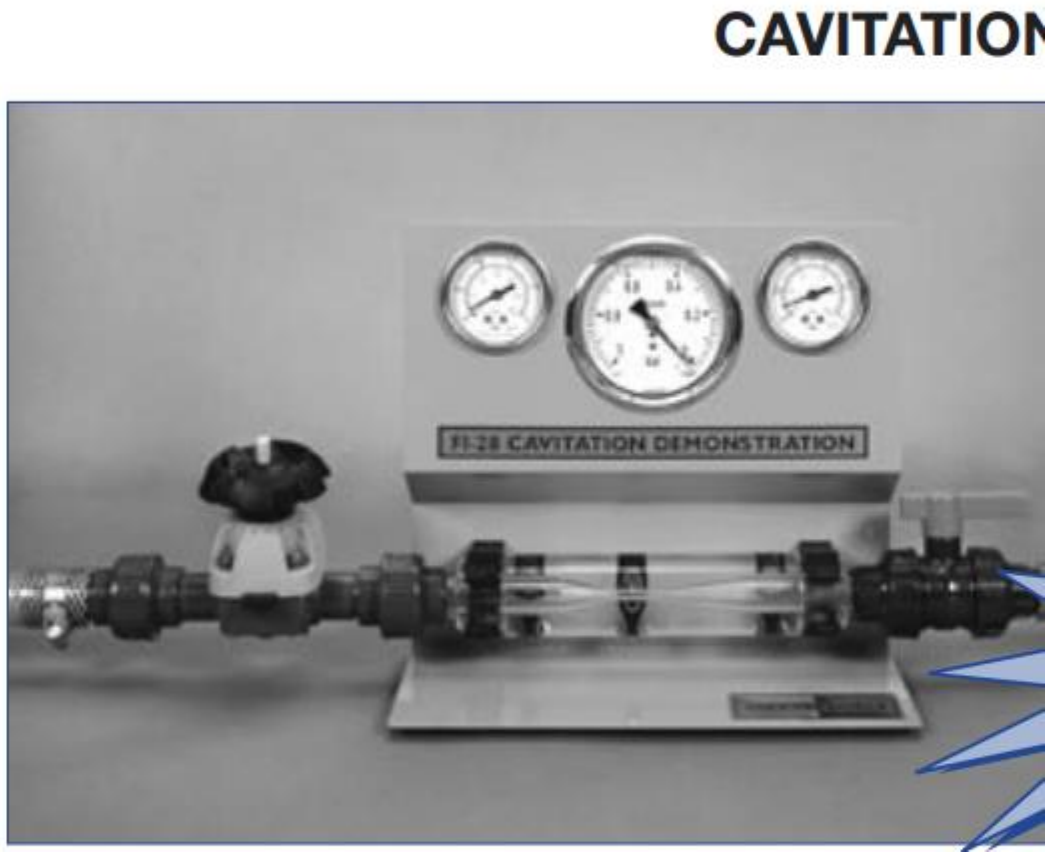


Figure 11: Parallel Pump Operation

5) **Cavitation Apparatus**



Cavitation apparatus

Technical Description

The apparatus consists of a circular Venturi-shaped test section manufactured from clear acrylic to allow full visualization of flow conditions inside the section. Water enters the test section at relatively low velocity. As the area of the test section contracts towards the throat the velocity of the water increases and the static pressure falls in accordance with the Bernoulli equation. If the flow of water is increased the sub-atmospheric pressure at the throat causes free and dissolved gasses to be released as bubbles in the liquid. As the flow is increased further the pressure continues to fall at the throat until a limit is reached corresponding to the Vapour Pressure of the liquid (the actual pressure depending on the temperature of the liquid). At this condition small bubbles of vapour are formed in the liquid. These bubbles collapse violently as the pressure rises again in the downstream expansion of the test section. This process is called Cavitation and can be regarded as one of the most destructive forces created in a liquid system – the large amounts of energy released resulting in erosion of even the hardest metal surfaces in real applications such as valve seats, propeller blades etc. Any further increase in the flow of liquid causes an increase in the Cavitation (the pressure cannot reduce any further than the Vapour Pressure of the liquid). The test section incorporates tappings that allow the static pressure upstream of the contraction, inside the throat and downstream of the expansion to be measured. Each tapping is connected to a Bourdon gauge of appropriate range. A flow control valve upstream of the test section allows the flow through the test section to be regulated without raising the static pressure in the test section, allowing Cavitation to be clearly demonstrated. Conversely a flow control valve downstream of the test section allows the static pressure in the test section to be elevated – a technique used to prevent cavitation from occurring

Cavitation is the name given to the phenomena that occurs at the solid boundaries of liquid streams when the pressure of the liquid is reduced to an absolute pressure that equals the vapor pressure of the liquid at the prevailing temperature. The static pressure in the liquid cannot fall below the vapor pressure and any attempt to reduce the static pressure below the vapor pressure merely causes the liquid to cavitate (vaporize) more vigorously.

Once the static pressure is reduced to the vapor pressure an audible crackling noise will be noticed that is created by the generation of vapor bubbles. If the sides of the pipe or the container are transparent then the milky appearance of the liquid, caused by the generation of vapor bubbles can be viewed as is the case in the venturi shaped test section of the cavitation demonstration apparatus.

Dissolved air in the water will also create air bubbles that look similar to cavitation but the air bubbles will be released at a higher static pressure (above the vapor pressure of the liquid). The release of the air bubbles is by no means as violent as cavitation and a softer noise is produced. As the static pressure of the liquid is gradually reduced below atmospheric pressure, air bubbles will be visible followed by true cavitation as the vapor pressure of the liquid is reached.

The bubbles of vapor formed in the region of low static pressure move downstream to a region of higher static pressure, where they collapse. This repeated formation and collapse of vapor bubbles can have such a devastating effect upon pipe walls, turbine blades, pump impellers etc. by causing pitting of the surface. The actual time between formation and collapse may be no more than 1/100th of a second, but the dynamic pressure caused by this phenomenon may be very severe. It is only a matter of having enough bubbles formed over a sufficient period of time for the destruction of the surface to begin.

6) Bourdon tube guage

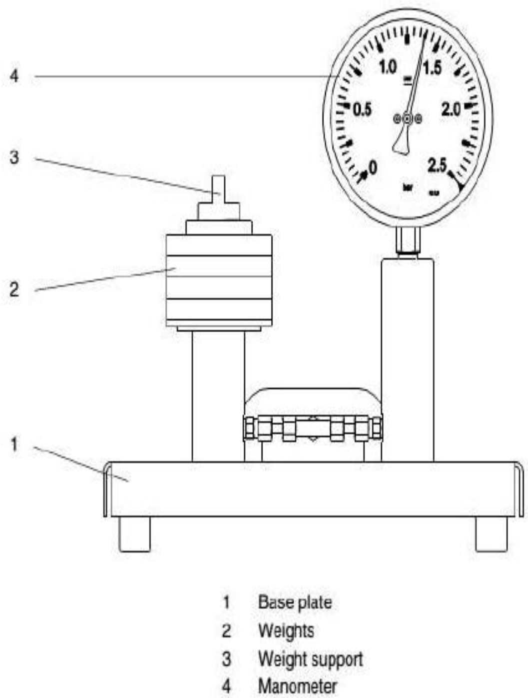


Figure 1: Dead Weight Piston Gauge

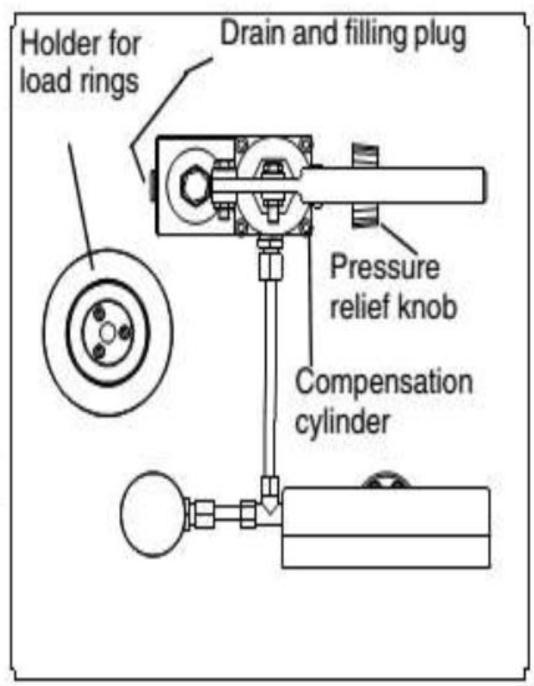


Figure 2: Dead Weight Piston Gage (Top view)

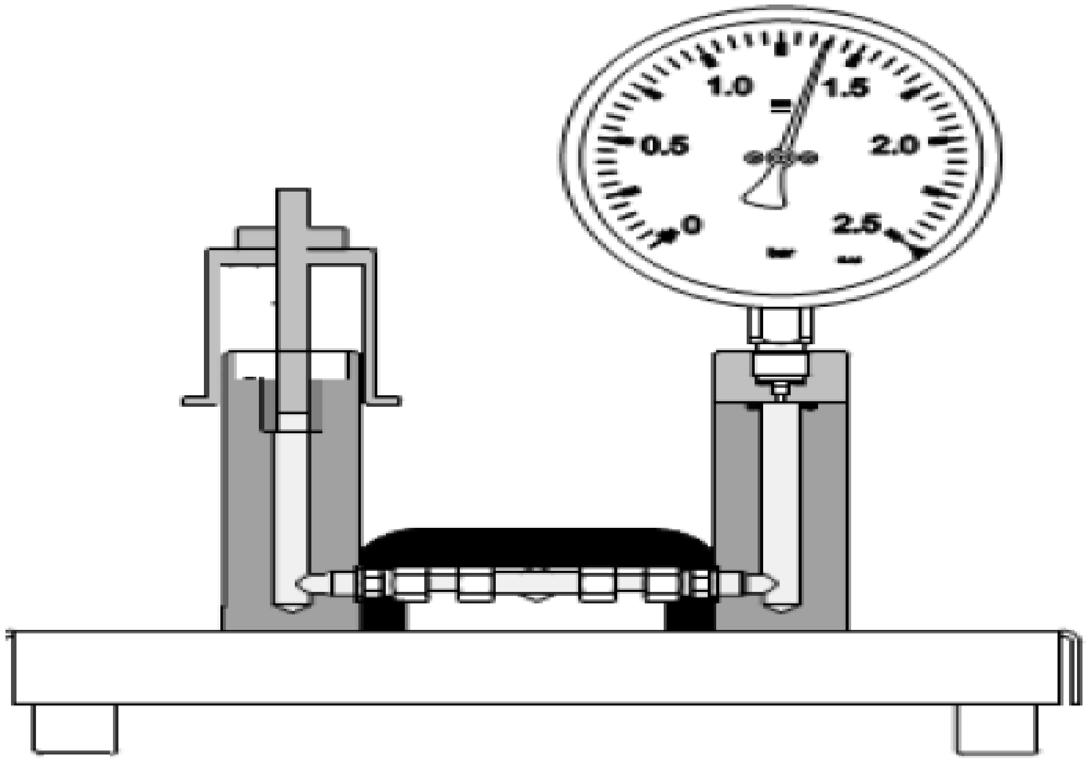


Figure 3: Fluid connections within the HM 150.02

Description

The purpose of the equipment is to demonstrate how a typical Bourdon gage may be tested and calibrated. It consists of a Bourdon type manometer with a transparent case to show the inner working mechanism of the gage. Pressure is applied to the gage by means of ring-shaped weights which are added on to a holder. The holder is connected to the pressure gage by means of a pipe containing oil. The oil converts the weight of the rings to pressure and transfers it to the piston gage. The compensation cylinder can be used to raise and lower the weight load on the oil cushion of the hydraulic oil. For the measurements, the load must be kept on the oil cushion so that the pressure is applied in the hydraulic system.