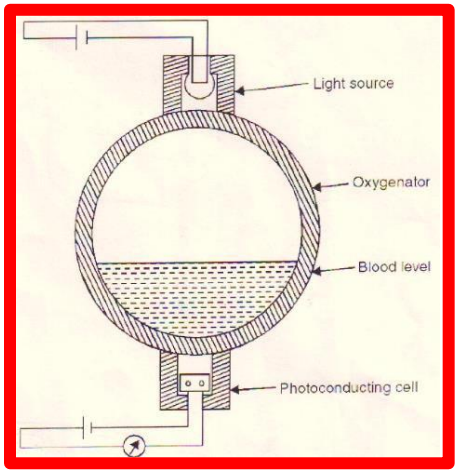
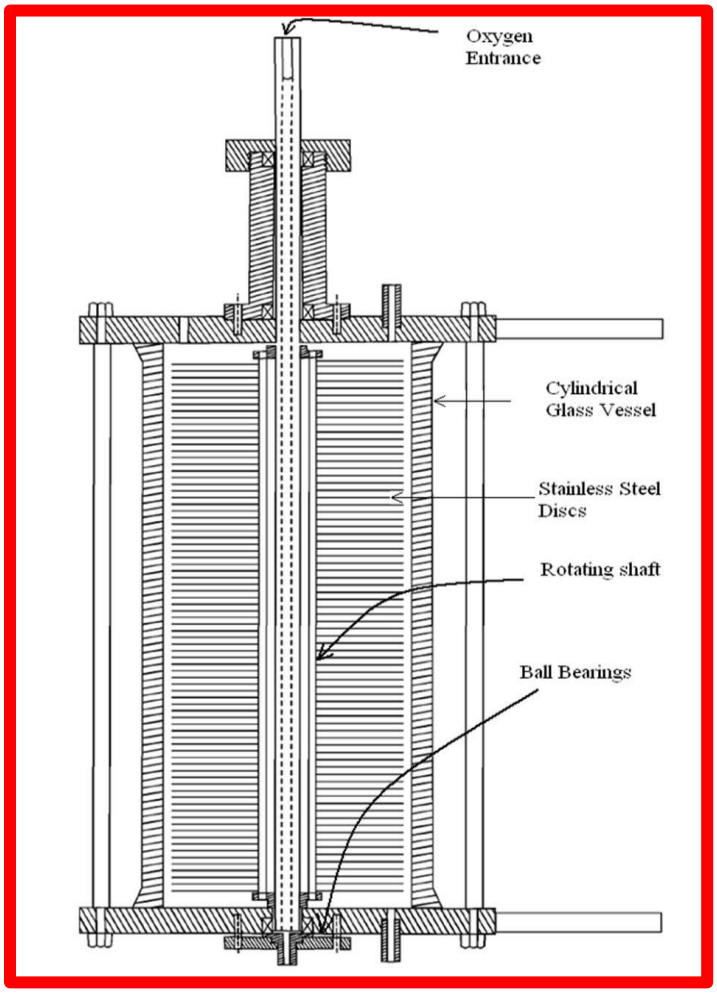
Design of the Oxygenator

- The oxygenator must be able to oxygenate up to 5 liters per minute from 65% oxygen saturation to 95% before the blood enter the physiological system. The natural lung have a wide surface area of about 50-100cm2 so the blood as a film of thickness of 0.005-0.01mm get oxygenated in a contact time of 40-50mSec.
- The inability to provide such extended surface area and thin blood film offers the greatest resistance to the oxygen transfer, this led the biomedical engineers to invent a rotating machine for oxygenation.
- To provide such an environment, the disk oxygenator is used as shown in the next figure. It consists of a cylindrical glass vessel of 15cm internal diameter, 38cm long in which 80-100 stainless steel disks of 0.6mm thickness and 14cm diameter are mounted axially with 3mm spacers between the discs. The shaft on which the discs are mounted is hollow and supported by three ill bearings at the end. The oxygen is fed through the axis of the shaft and it enters the oxygenator through the distributing apertures on the circumstance of the shaft.
- The optimum blood level in the oxygenator that provides the maximum film area for a given priming volume is 0.7R where R is the radius of the disc. For this blood level in the oxygenator, the values of the various design parameters as number of discs, diameter of discs, and length of the oxygenator are determined for given requirements of oxygenation.

- For this disc oxygenator, with blood level of 0.7R, the available film area is 1.47m2 and the prime volume is 2.19 liters. To oxygenate 5 liters per minute of blood would require a rotating speed of about 150r.p.m.
- The oxygenation capacity can be varied, by varying rotating speed or by changing the number of discs.
- The blood level is a photo-electric level sensor. The sensing element is a photo conducting cell which conducts depending on the light radiation it receives.
- The light source is fixed on the top of the oxygenator shown in the next figure, and the light reaching the photodiode depends on the blood level in the oxygenator. If we know the signal corresponding to the blood level 0.7R, we can suitably adjust the pump flow rate. Manual control is replaced by feedback control of the power supply of the motor using the signal from the photo sensor.





Heat Exchanger:

- The heat exchanger is single pass, shell and tube heat exchanger with blood flowing on the shell side and water flowing on the tube side.
- The priming volume of heat exchanger is about 250 ml and blood flows as thin film in the space between shell and tube.
- The temperature of blood stream and water stream are monitored.

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The Cardiopulmonary Bypass Circuit

- The circuit of heart-lung bypass circuit is shown below. One of the pumps is connected to the suction line and the other on the arterial line.
- Oxygen flow is regulated in the range of 0-15 liters per minute with a rotameter and needle valve flow controller.
- The arterial and venous pressures gauges are provided.
- The blood from the heat exchanger is passed through a **bubble trap** before it is returned to the patient.
- The role of physical factors such as oxygen saturation of incoming blood, the blood distributing system in the oxygenator, oxygen carrying capacity of the blood under given conditions, the blood flow rate, temperature of the oxygenation, partial pressures of the oxygen etc. All tell upon the performance of the oxygenator.

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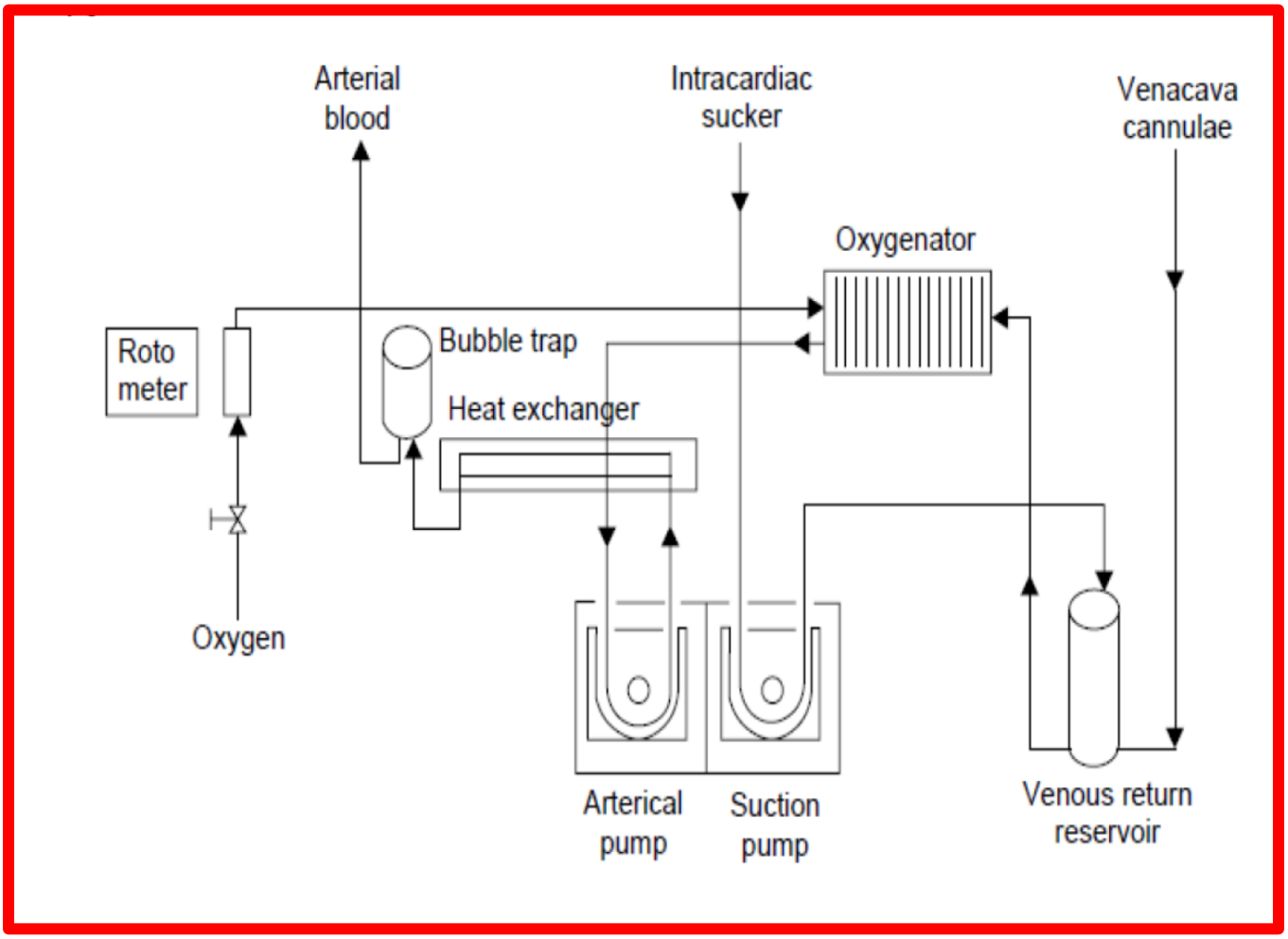

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