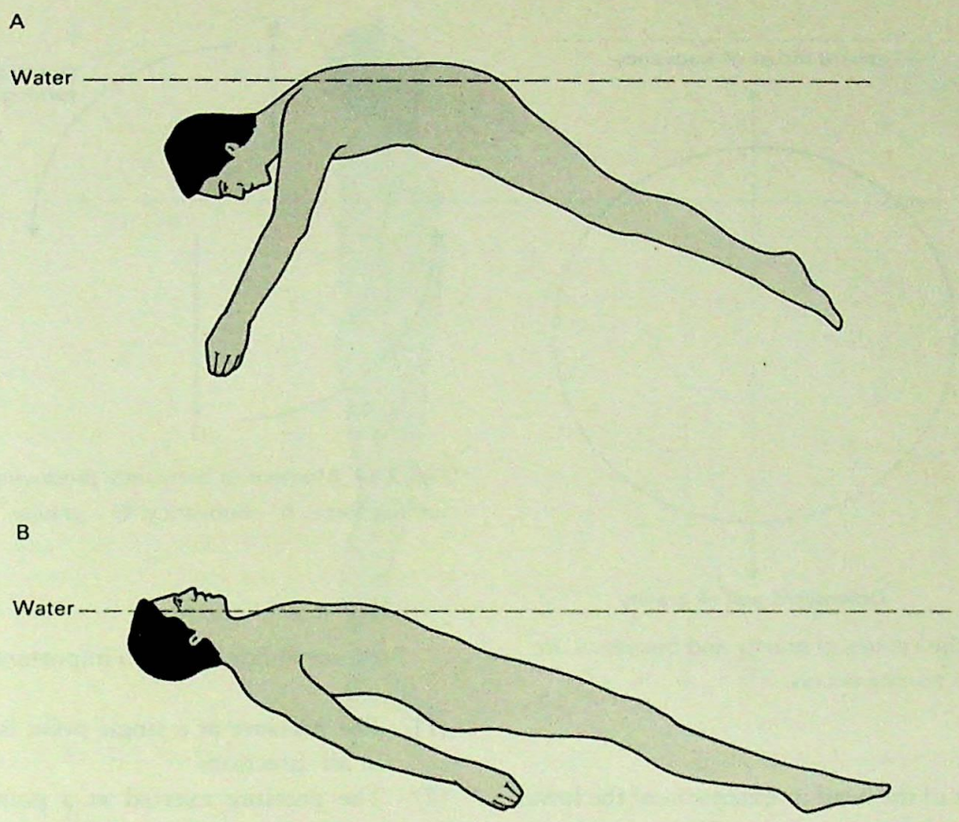

Fig. 2.52 Floating body. A, Prone; B, Supine.

centre need not coincide with the centre of gravity.

The human body will seem 'lighter' when wholly or partially submerged. The therapist can make use of this in the hydrotherapy pool. It both allows the patient to be easily manoeuvred by the therapist and facilitates their movements and postures. It is, for example, easier for a very weak patient to stand upright and maintain the position in the pool.

Moment of buoyancy

If a floating body is to remain in a position of equilibrium, the centres of buoyancy and gravity must lie in the same vertical line (Fig. 2.53). When they are not in line a turning force or couple is produced, the body moving toward a position of equilibrium. This turning force is known as the moment of buoyancy (Fig. 2.54). The effect of the moment of buoyancy can be seen quite clearly in the hydrotherapy pool when treating patients. Figures 2.55A and B show the force being used to advantage when asking the patient to move from the standing to lying position and vice versa. Taking the head backwards will produce a moment which will lead to lying; bending the head forwards will allow the patient to stand again. Figure 2.56 shows the same rotation occurring with the patient in sitting; this follows a backward

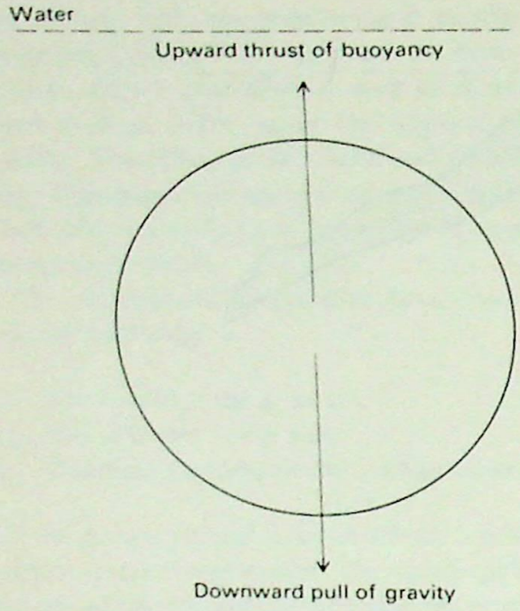

Fig. 2.53 The centres of gravity and buoyancy are in line – no turning occurs.

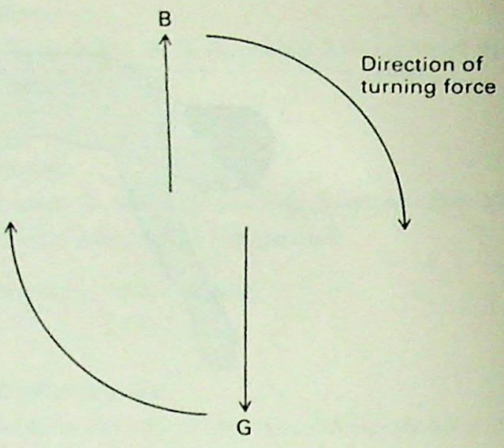

Fig. 2.54 Moment of buoyancy producing a turning force. B – buoyancy. G – gravity.

movement of the head or extension of the lower leg. When the patient is required to sit in the pool and exercise the lower leg it is advisable to counter the natural rotation caused by leg extension by suggesting that they bend the head forwards.

Pressure

Pressure is experienced by a fluid when a force is applied to that fluid when contained in a confined space (Fig. 2.57):

Pressure = force/area

Pressure within a fluid is also the result of the force applied by the weight of the fluid above a given point. The greater the height of the column of fluid in question the greater the pressure. Figure 2.58 shows how pressure increases with depth. To this fluid pressure should be added the value of the atmospheric pressure; this is usually about 101.3 kN/m^2.

Pressure in fluid has two important features:

(1) The pressure at a single point is the same in all directions
(2) The pressure exerted at a point on any surface is normal to that surface (Fig. 2.59).

It is very unlikely that the pressure exerted by the water in a hydrotherapy pool will have much effect upon oedema of the tissues as has been claimed in the past. Any reduction of swelling is more likely to be the result of an increase in temperature improving the circulation and the effect of the exercises. However, it has been noted that patients suffering from respiratory distress may have increased problems due to the pressure of the water on their chests when submerged.

Hydrodynamics

Hydrodynamics is the study of fluid in motion. Two types of flow pattern occur as a result of this motion:

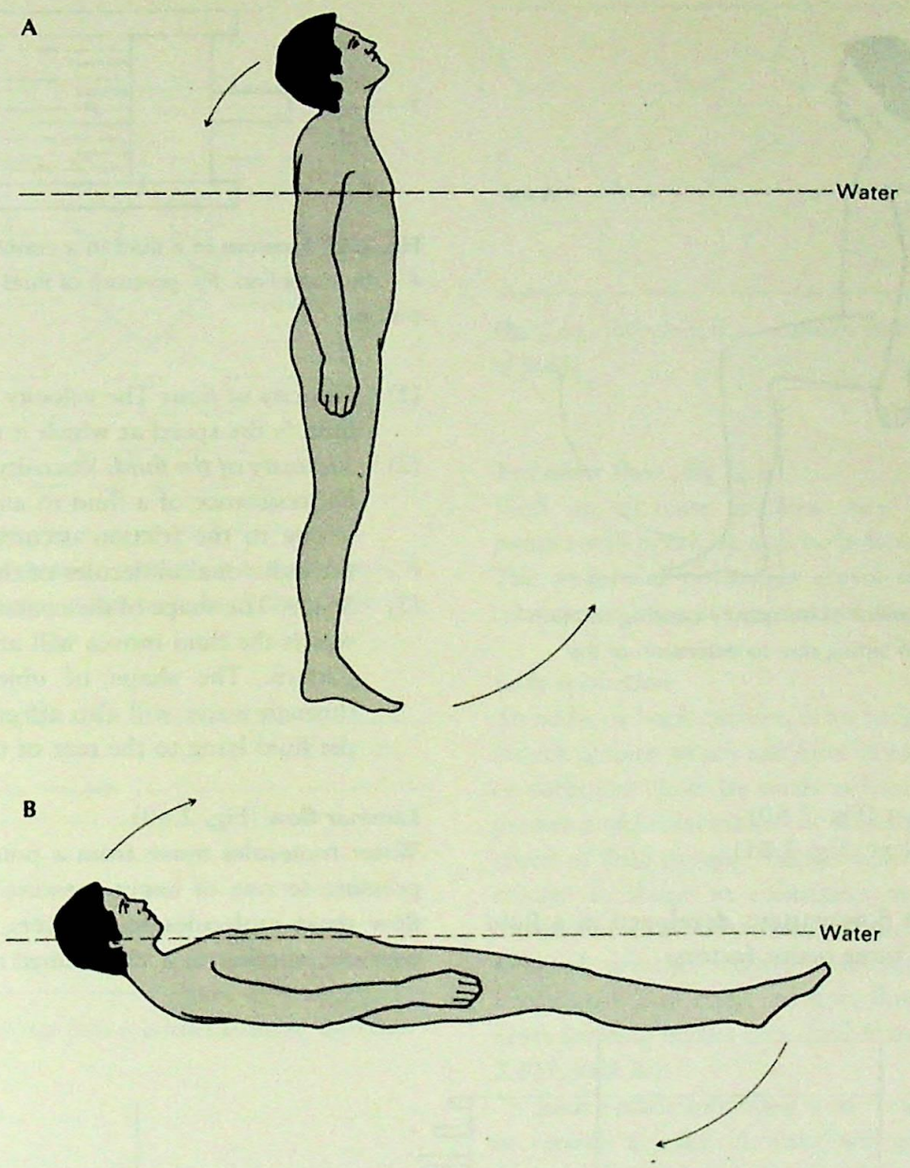

Fig. 2.55 Moment of buoyancy applied to the human body. A, standing to lying; B, lying to standing.

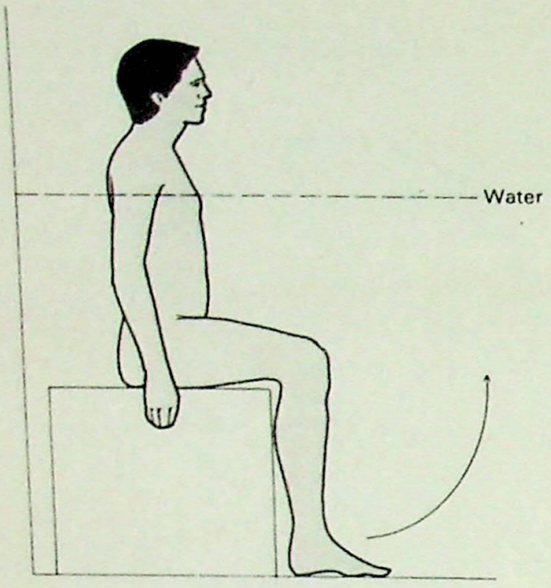

Fig. 2.56 Moment of buoyancy causing rotation of the body in sitting due to extension of the lower leg.

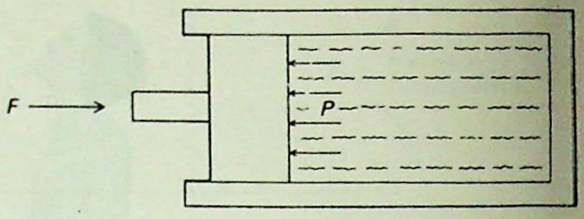

Fig. 2.57 Pressure in a fluid in a confined space. *F* – force applied. *P* – pressure of fluid against piston.

(1) Laminar (Fig. 2.60)
(2) Turbulent (Fig. 2.61).

The type of flow pattern developed in a fluid depends on three major factors:

(1) *Velocity of flow.* The velocity of flow of a fluid is the speed at which it moves.
(2) *Viscosity of the fluid.* Viscosity is the internal resistance of a fluid to any change. It is due to the friction occurring between the individual molecules of the liquid.
(3) *Shape.* The shape of the container through which the fluid moves will affect its flow pattern. The shape of objects moving through water will also affect the flow in the fluid lying to the rear of the body.

Laminar flow (Fig. 2.60)
Water molecules move from a point of higher pressure to one of lower pressure. In laminar flow these molecules form layers which slide over one another in a streamlined manner. The

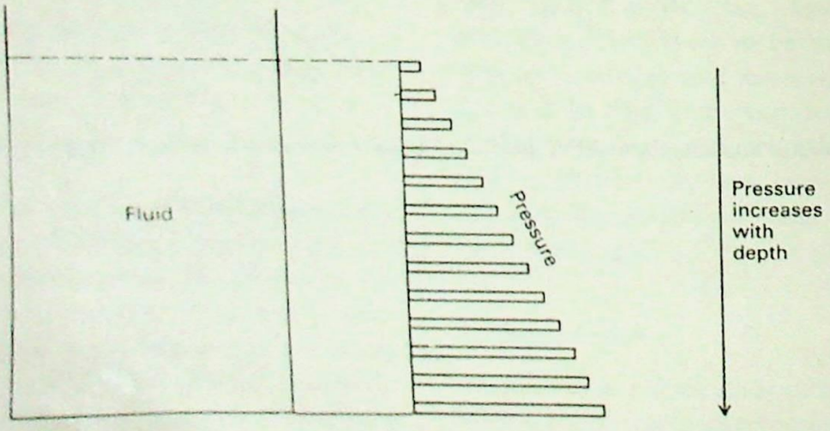

Fig. 2.58 Pressure in a fluid increases with depth.

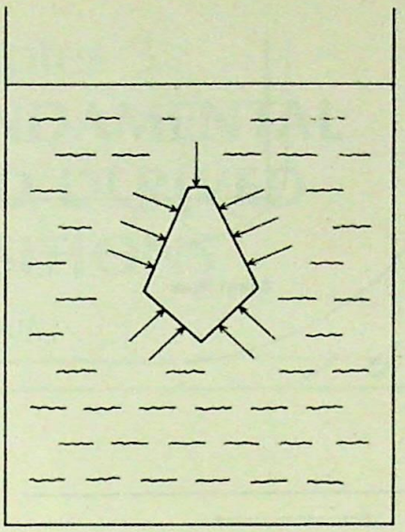

Fig. 2.59 The pressure exerted on a minute body is equal and normal to that body in all directions.

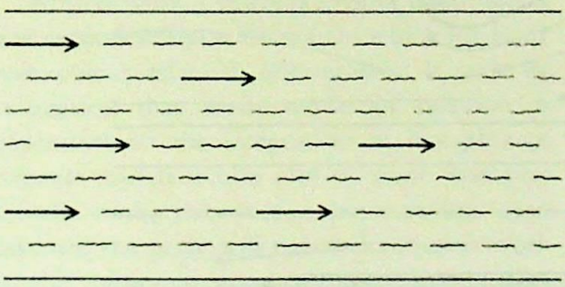

Fig. 2.60 Laminar flow – arrows indicate direction of flow.

path of the molecule is in the same line as that of the general flow. Viscous friction occurs between these adjacent layers, impeding the flow of the fluid. The greater the viscosity of the fluid the greater will be the impediment and thus the slower the flow. Laminar flow only occurs with low velocity fluid movement and it will therefore be seen that fluids of higher viscosity have a greater tendency towards laminar flow.

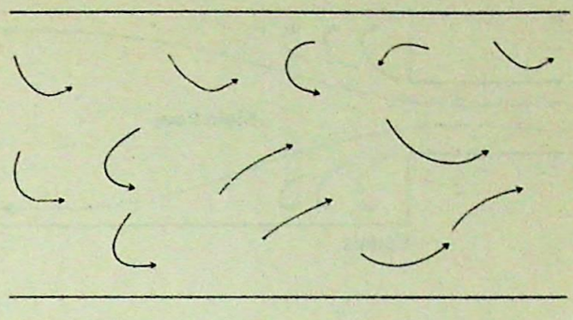

Fig. 2.61 Turbulent flow – arrows indicate motion of fluid.

Turbulent flow (Fig. 2.61)
With an increase in flow rate the laminar pattern will break up and turbulence will occur. The molecules no longer travel in layers but take on an irregular pattern of motion.

Eddy formation
An eddy, or back current, is an exaggerated turbulent pattern which can arise in either laminar or turbulent flow. Its onset is hastened by the presence of initial turbulent flow and increased speed of fluid motion. Eddies arise at points of change in shape in containers or follow the movement of a body through fluid. An area of reduced pressure forms downstream of the irregularity and back currents flow into these areas forming eddies (Fig. 2.62A and B and Fig. 2.63A and B).

Such eddies following a moving body may be termed a wake. A wake will give rise to a drag force which will impede the movement of the object. This effect can be reduced by streamlining the shape of the body (Fig. 2.63B).

The therapist makes considerable use of these factors when treating patients in water. Slow movement of the patient through the medium facilitates laminar flow of the water and consequently there is less resistance to movement.

Further reduction in eddy formation may be

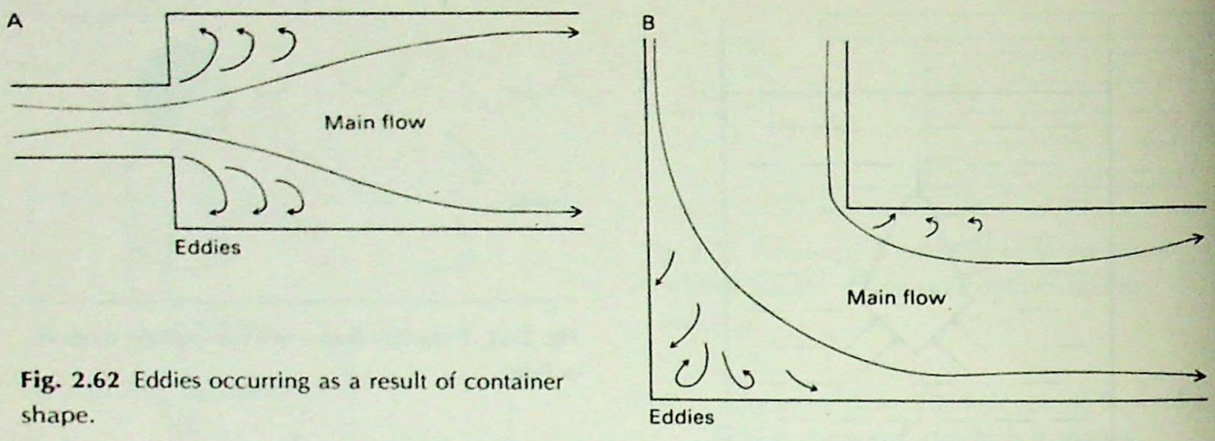

Fig. 2.62 Eddies occurring as a result of container shape.

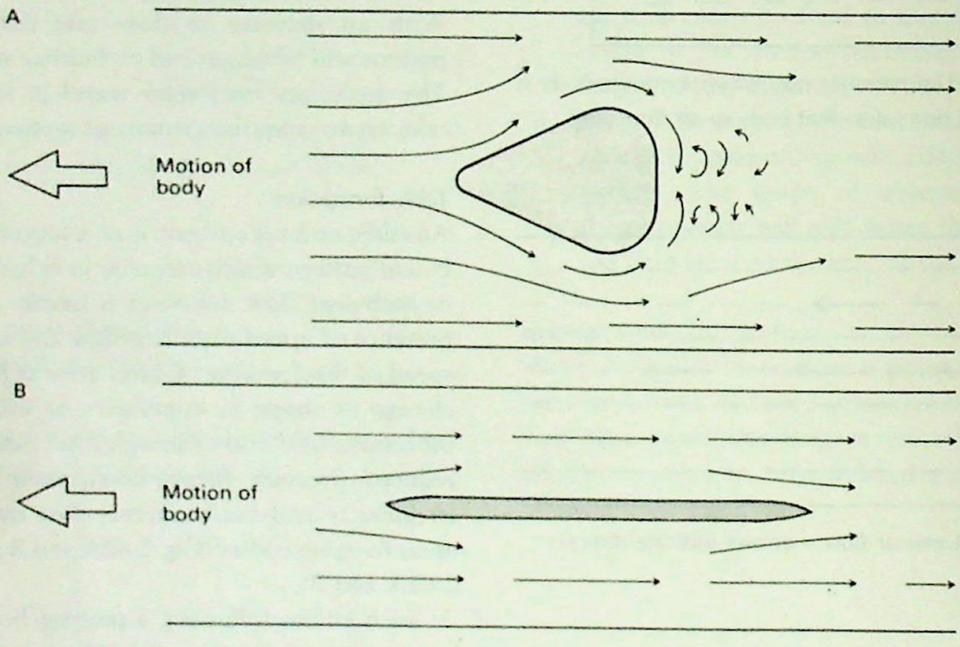

Fig. 2.63 A, Bluff body moving through fluid; B, Streamlined body moving through fluid.

achieved by presenting the most streamlined aspect of the body to the water. Thus it will be found that walking sideways (slowly) through the water is much easier than walking forward (quickly). Use may be made of the resistance offered by the water; bats are sometimes used in order to present large surface areas to the fluid, encouraging the formation of a wake.