acting on the vertical flat plate (A) so that the bar (B), which rotates horizontally and freely about its centre, is aligned with the direction of the wind. The other end of the bar is the pointer which indicates the direction from which the wind blows. The position of the pointer can be registered on a digital or dial display, and can be continuously recorded on a chart, often sited at some distance from the mast itself.

The anemometer consists of three hemispherical cups with beaded edges held vertically on horizontal bars of equal length, which radiate at 120° apart from a central pivot (Fig. 7.1). The cups are designed to achieve a turbulent-free flow of air. As the pressure of the wind on the concave side of the cups is greater than on the convex side, the cups rotate and operate a small electrical generator which produces a current. The value of the current is related to the speed of rotation and hence the wind speed. Thus the wind speed can be registered in the same way as the wind vane data.

## Sea Observations

In the 19th Century, Admiral Beaufort introduced the *Beaufort Scale*, a scale from 0–12 called *Beaufort Force* numbers, each number corresponding to a range of wind speeds. Originally expressed in terms of the effect on a man of war and the setting of sails, today it is based on the state of the sea (Table 7.1 and Plates 30–42)). The sea criteria are the wind waves which are generated by the wind which has been in existence for a reasonable period, and having an adequate *fetch* (the distance of open water over which the wind has blown). However, the wind is not the only factor influencing the sea state, and allowances should be made for tides, currents, depth of water and precipitation, where these are seen to affect the sea state. Tides opposing the direction of the wind waves will create more "lop", and an overestimate of wind speed is possible. Heavy precipitation flattens the sea and may lead to an underestimation. Wind direction is established by observing the direction from which the wind waves advance.

Waves generated by winds at some distance from, or at some time previously at the point of observation also affect the sea. This wave motion is called *swell*, and is excluded when recording the Beaufort Force. Swell, in contrast to wind waves, has a long and generally low regular wave form (Plate 43). It may be at any angle to the wind waves, and more than one swell may exist at the same time. Thus swell gives a useful indication of conditions existing, or which existed at some distance in the direction from which it is coming. Swell generated by wind conditions in the Southern Oceans has often been observed in the Western Approaches to the British Isles. The presence of swell may also be one of the earliest indications of a tropical cyclone.

For meteorological purposes the period and height of wind waves and swell, and the direction from which the swell is coming are recorded. The period of a wave is the time taken for the passage of two successive crests past a point selected by the observer. The height of the wave is the vertical distance between the bottom of the trough and the top of the crest. As waves normally occur in groups, the height and period are assessed by observing two or more of the relatively large waves in each group, until at least ten such waves have been observed. The period is the average value of the recorded times, and the height is the average value of the heights observed. Table 7.1 includes a guide to the classification of wind waves related to wind speed. The following table is a guide to the classification of swell waves:

Table 7.2 Swell Waves

| *Length* | | *Height* | |
|---|---|---|---|
| *Description* | *Length (m)* | *Description* | *Height (m)* |
| Short | 0–100 | Low | 0–2 |
| Average | 100–200 | Moderate | 2–4 |
| Long | >200 | Heavy | >4 |

Conditions at sea often preclude an accurate observation of the sea state and the use of the Beaufort Scale. On these occasions the wind vane and anemometer, funnel smoke, and flags can be observed to establish the relative wind speed and direction. As the true wind is required, it is derived using a vector