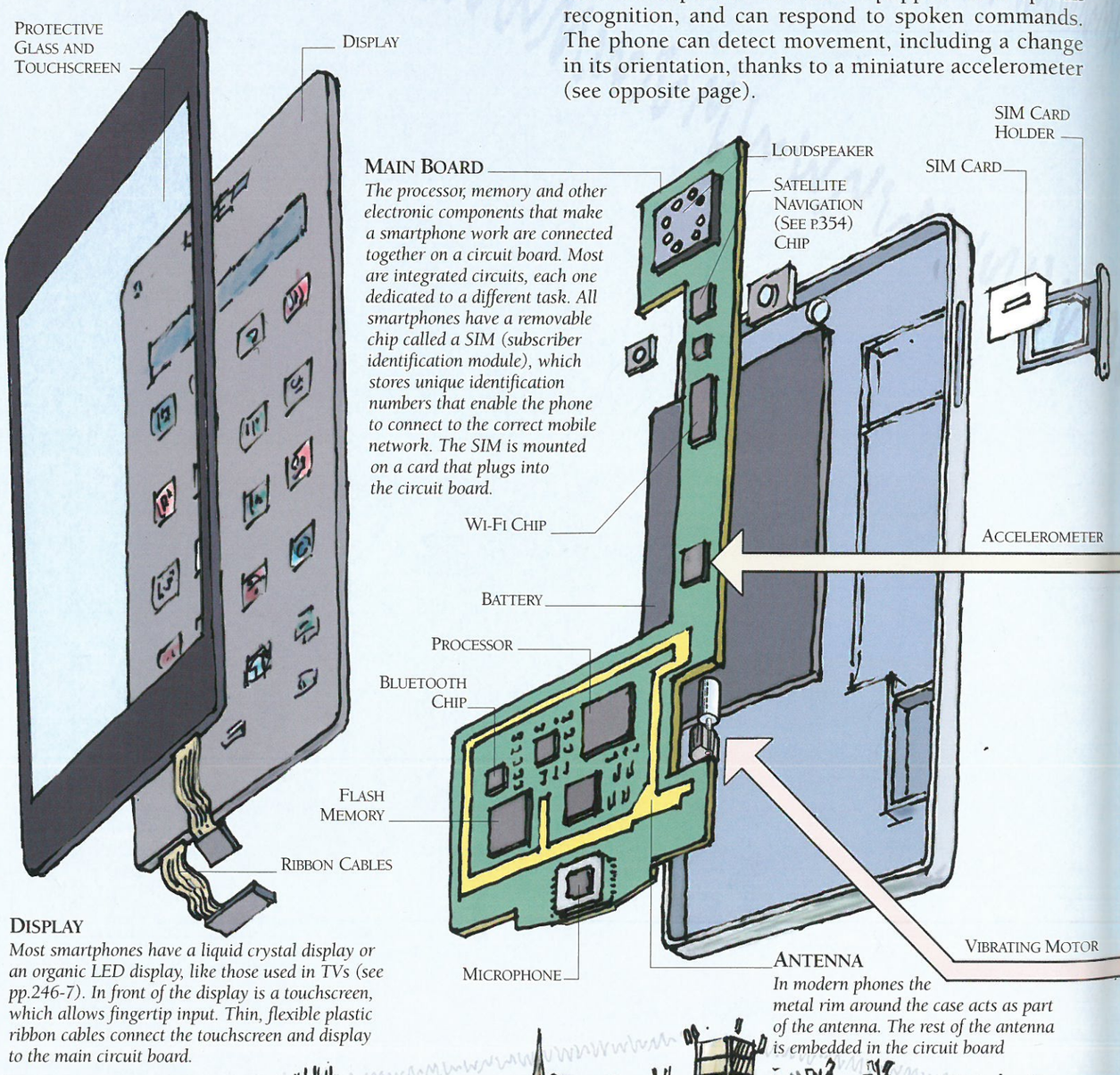
SMARTPHONE

A smartphone is really a handheld computer that can run a wide range of different software applications (apps), including web browsers, as well as communicating via the telephone network. An antenna allows it to send and receive radio waves encoded with digital sound, using the same techniques as digital radio broadcasting. A microphone picks up the caller's speech, and can record sounds. A small loudspeaker produces the sound of the other person's voice, and can also play music. The speaker also alerts the user to incoming calls and messages, while a vibrating motor can achieve the same thing by making the phone buzz. The main form of input is a touchscreen, although most smartphones are also equipped with speech recognition, and can respond to spoken commands. The phone can detect movement, including a change in its orientation, thanks to a miniature accelerometer (see opposite page).

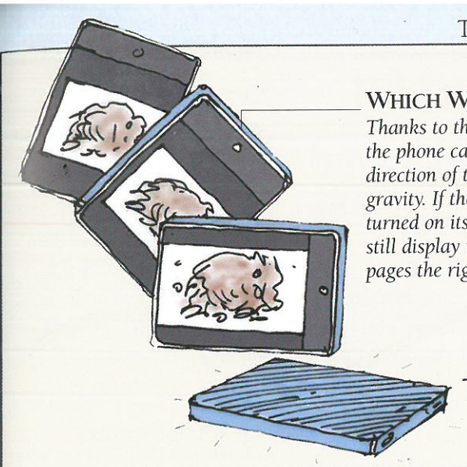


Display

Most smartphones have a liquid crystal display or an organic LED display, like those used in TVs (see pp.246-7). In front of the display is a touchscreen, which allows fingertip input. Thin, flexible plastic ribbon cables connect the touchscreen and display to the main circuit board.

Antenna

In modern phones the metal rim around the case acts as part of the antenna. The rest of the antenna is embedded in the circuit board

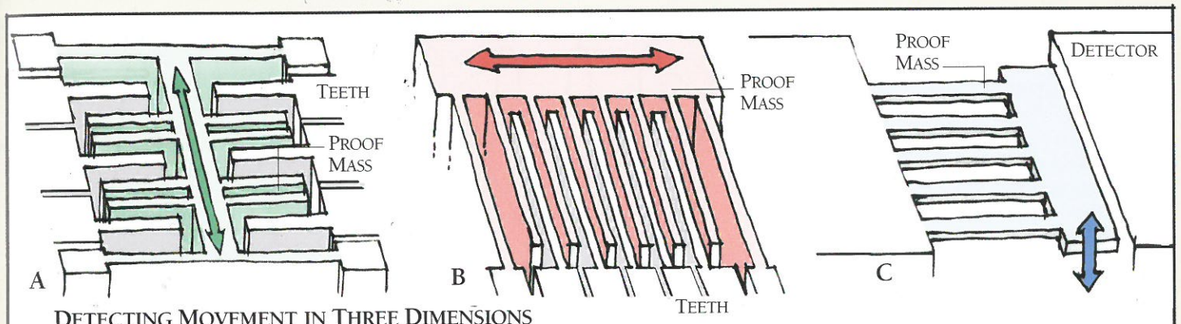


Which Way Up?

Thanks to the accelerometer, the phone can detect the direction of the force of gravity. If the phone is turned on its side, it will still display images or web pages the right way up.

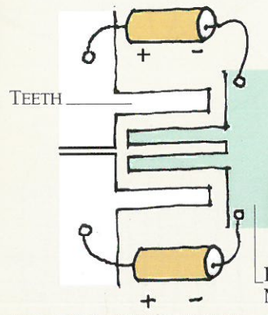
Accelerometer

A smartphone accelerometer works on the same principle as the accelerometer found in an autopilot (see p.293), but it is much smaller. It can detect changes in the speed of the phone, such as sudden movements – and crucially it can detect changes in the phone's orientation. The accelerometer is particularly useful when displaying images or playing games, both of which need the display to switch between portrait (upright) and landscape (on its side) orientations. The accelerometer in a smartphone is a tiny chip made by sculpting silicon, using similar techniques to those used in manufacturing microprocessors (see pp.342-3).



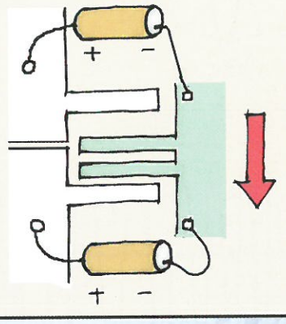
Detecting Movement in Three Dimensions

There are three sections to the accelerometer, each detecting accelerations in one axis: backwards-forwards (A), left-right (B) and up-down (C). The first two are composed of a large number of very thin silicon "teeth" set close to a moving weight called a proof mass. The other section works in a similar way, but the proof mass moves up and down next to a silicon detector.



Phone Not Moving

The accelerometer's teeth and the proof mass are both connected to the phone's battery. This means the proof mass is electrically charged, and there is an electric field between adjacent teeth, but when the proof mass is not moving, no current can flow.



Phone Moving

When the proof mass moves, its electric charge disrupts the electric field around the teeth. This causes electric charges to move around the circuit. In other words, it creates an electric current. The phone's processor compares currents in each of the three axes to work out how much the phone is moving and in which direction.

Silent Mode

A smartphone can be set to silent, so that it doesn't ring out loud. When the phone is in silent mode a user can still be alerted to calls and messages, thanks to a vibrating motor. This is a small electric motor with an off-centre mass attached to the spindle. The whole motor vibrates, in the same way that a spin dryer shakes when all the wet clothes inside it have bunched up on one side. The same technology is used in games controllers (see p.328) to make the controller shake in your hands when a certain action has been completed (sometimes called "haptic" or force feedback).