Crystal Clear

Liquid Crystal Displays, featured widely on watches and calculators, are now starting to appear on computers

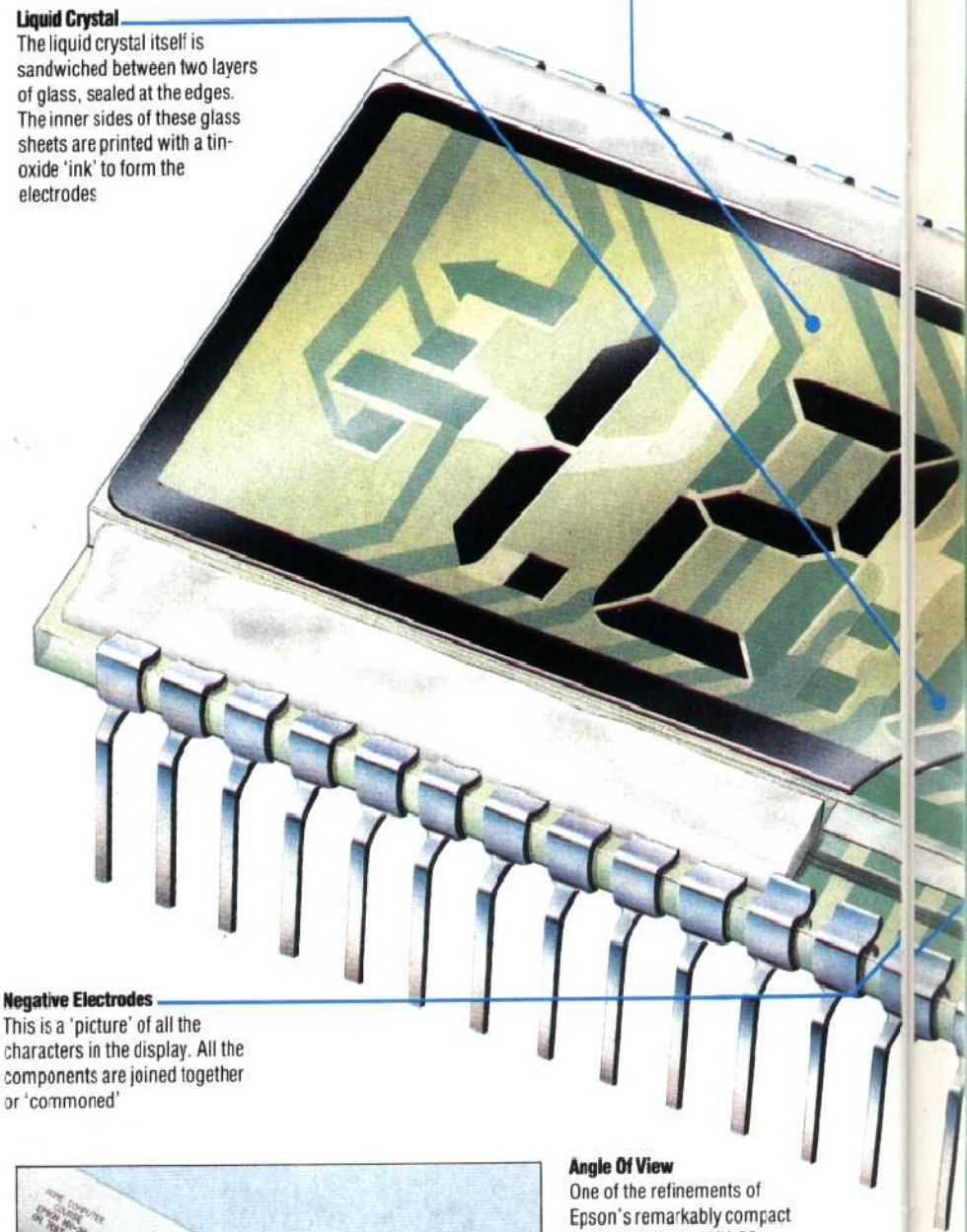
Liquid Crystal Displays (LCDs) have been available since late 1973, when they first made their appearance in calculators. Later they were employed in the production of digital watches, and greatly contributed to the popularity of that type of watch. Now LCDs are beginning to find a place in the microcomputer industry. They are used in the A4-sized portables like Epson's HX-20 (see page 169), and the Tandy TRS80 Model 100 Portable Computer, as well as Sharp's high capacity PC 5000.

In order to understand what liquid crystals are, we must first appreciate that all matter varies its physical state depending on temperature and pressure, from solid (or crystalline) through liquid to gas. Only in the solid state is any regular alignment of a substance's molecules to be found. That is, except in the case of a very few substances where that regular alignment is maintained part way through into the liquid state. These substances, the nature of which is a closely guarded trade secret, are known as liquid crystals.

Until the mid-seventies, displays in calculators and watches were composed of bar-shaped Light Emitting Diodes (LEDs), arranged to form a rather angular version of a letter or number. But LED displays have several drawbacks: they require considerable amounts of power and are relatively large in size.

In the search for alternative methods of information display, it was discovered that the alignment of the molecules in liquid crystals could be altered by an electric current; and furthermore, this alteration was purely a local one. Once this principle had been established, it became possible to construct a medium for displaying information. The first step involved forming electrodes in the shape of a character on the inside faces of two sheets of glass. A very thin layer of liquid crystal was sandwiched between these, and a voltage applied. In ordinary light, nothing appeared to happen, but when polarising filters (see diagram) were applied to the back and front and the whole structure mounted against a reflective background, the desired effect was produced — a clearly-defined character against a neutral background.

The process by which this character is defined requires light to pass through the first filter, and in this way to be polarised vertically. It is then deflected through 90°, and thus is blocked out at the rear filter. In this way, the area of the liquid crystal to which a voltage has been applied



Vertical Polarising Filter
The polarising filter in front of the display cuts out all but vertically-oscillating light waves. It incorporates an ultra-violet filter to prolong the liquid crystal's life

Liquid Crystal
The liquid crystal itself is sandwiched between two layers of glass, sealed at the edges. The inner sides of these glass sheets are printed with a tin-oxide 'ink' to form the electrodes

Negative Electrodes
This is a 'picture' of all the characters in the display. All the components are joined together or 'commoned'

Angle Of View
One of the refinements of Epson's remarkably compact and sophisticated HX-20 portable computer is the angle of view adjuster. Liquid crystals are composed of long thin molecules that have magnetic poles positioned in the middle of their long sides. Applying an electrical voltage across their length causes them to try to twist end over end, while their natural stability attempts to keep them in place. The greater the current passed, the more they will twist