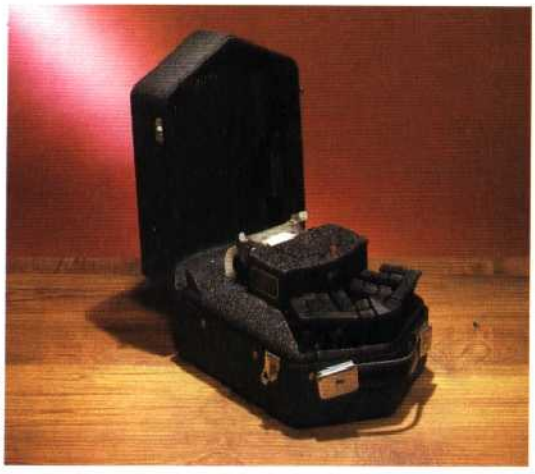
centre of the screen. This can be easily achieved by placing a book or two under the front of the set. However, you may encounter another problem at this point — your own reflection in the screen. A filter with a matt surface will remove this quite effectively.

Once the screen has been made comfortable to use, we can go on to consider the physical layout and attributes of the keyboard. The most important factors are the height of the keys above the desk on which the keyboard is placed, and the angle of the rows of keys relative to each other. In ideal circumstances, the keyboard will be low enough for the operator's wrists and forearms to rest flat on the desk in front of it, and it should be adjustable for rake. Unfortunately, few home microcomputers are designed with the required low profile. Sinclair's ZX series, the Oric-1 and the Jupiter Ace are exceptions, but they all have even greater problems with their keyboards because of their use of either multi-layer membranes or moulded rubber sheets in place of sprung keys. Multi-layer membranes have no 'feel' whatsoever, and in the case of the ZX80 and 81, are spaced in such a way as to defy anyone to touch-type on them. The combination of these factors makes entering long programs an exhausting task. The Oric-1 and Spectrum attempt to circumvent this problem by producing an audible signal that a key has been depressed sufficiently to make contact. But that is hardly an adequate compensation. There are a number of companies supplying alternative keyboards — full size, with sprung keys — for the Sinclair computers, but the well designed examples are expensive. They also maintain the single key entry convention devised by Sinclair to speed operation in BASIC, which is a constant source of irritation for even a semi-skilled typist.

The ideal layout of a keyboard requires the rows of keys, as viewed from the side, to be arranged as if to form part of the circumference of a drum. This would minimise the directional movement of the typist's fingers. The only home computers that fit this specification are: the BBC Micro, the Commodore 64 (as well as the later Vic-20s), and the Apple II.



MARTIN BURKE

The Shorthand Machine
Where there is a need to record speech, and the stenographer has no means of slowing the speaker down, a device known as a Palantype is often employed. Shorthand machines of this type use a shorthand version of the phonetic spelling

The layout of the keyboard itself has long been a major bone of contention with designers. When typewriters first became available in the 19th century, there were as many different keyboard layouts as there were manufacturers, but in general the most frequently used character keys were grouped together at the centre of the keyboard. When the 'typebasket' was introduced, in the 1870's, manufacturers discovered that even quite slow typists could cause the type bars to jam against each other. The problem occurred most frequently with words such as 'ten', where the commonly used letters in the English language (which were conveniently placed next to each other on the keyboard) were used in rapid succession. The solution adopted was to move those letters most often found adjacent to each other in words, further apart in the typebasket — hence the now standard QWERTY keyboard, designed by Scholes and Gliden in the United States. There is no reason at all why an electronic keyboard should be constrained by this layout except to maintain a standard approach — an interesting example of a *de facto* global standard becoming undesirable and yet impossible to change.

However, some efforts to develop alternative keyboards have been made. In 1977, Mrs Lillian G. Malt employed the flexibility inherent in electronics hardware to produce a keyboard shaped to fit the hand, which is considerably less tiring to use than the standard design. It is also much quicker in operation — reports of 300 and more words per minute are commonplace. Unfortunately, it has not succeeded in breaking the QWERTY stranglehold on keyboard layout.

One very useful feature that this keyboard (called the Maltron) shares with many microcomputers is detachability. Most home computers do not have built-in monitors and are themselves small enough to be moved around, but this is not the case with many microcomputers designed for office use. Increasingly, keyboards are being designed to be as slim as possible and are attached to the microcomputer by an umbilical cord. IBM's PC Junior has gone one step further: the communications link between the keyboard and the microcomputer is similar to television and video recorder remote controls, and works by means of infra-red light.

Because ergonomics is not a totally objective science — it is the study of how workers *relate* to their working environment, and that relationship tends to change from time to time — it is not possible to give hard and fast rules. The keynote is long-term comfort. This requires the arrangement of tools and equipment so that all your energies can be devoted to the task in hand, without it being necessary to change position constantly, and without becoming unduly tired.

There are several further things that the home computer user can experiment with in order to improve his working environment. When we discussed Apple's Lisa (see page 261), we noted that there were alternatives to the keyboard when