The Oscilloscope

1 The oscilloscope is *a* ***versatile*** instrument and it is used to measure the characteristics of both d.c. voltages and a.c. voltages. An oscilloscope can display on its screen part of a rapidly changing waveform so that measurements can be made of the frequency, shape and period of the waveform. It is therefore widely used in the design and development of amplifiers, music synthesisers, televisions, radios and computers. Oscilloscopes are generally operated from the mains power supply for use in laboratories and workshops. ***Portable*** battery-operated oscilloscopes are available for engineers and scientists working outdoors.

2 The full name for an oscilloscope is cathode-ray oscilloscope (CRO) since its main component is a **cathode-ray tube** (CRT). The CRT is also used in televisions, visual display units and radar sets. It incorporates an electron gun which "fires" a single narrow beam of rapidly moving electrons (cathode rays) at a phosphor coated screen which glows at the point where the beam strikes it. By moving the electron beam ***in sympathy with*** the signal waveform, it is possible to "write" a graph (a trace) of the waveform on the screen. A dual-trace oscilloscope enables the shape of two waveforms to be written on the screen simultaneously. This is achieved by electronic circuits that rapidly move the electron beam to separate parts of the screen to give the impression that there are two independent beams. This enables the comparison of the shapes of two waveforms. The more costly dual-beam oscilloscopes have two electron guns and they can produce the shape of two higher frequency waveforms simultaneously.

3 The inside surface of the screen of a cathode-ray tube is coated with a phosphor which lights up, or fluoresces, when electrons strike it. Different phosphors produce different colours of light, ***though*** green is favoured for most scopes. Of course, once the phosphor has been activated by the impact of the electrons, its light must fade away within a few milliseconds if the trace is not to linger and confuse the picture. However, some cathode-ray tubes are designed to capture the shape of a single waveform so that it can be examined easily. For example, an electrocardiograph uses a cathode-ray tube which retains the waveform of heart beats for a few seconds: and so does a radar screen which marks the position of aircraft by the "echo" of radio waves which bounce off them. Note that the cathode-ray tube in a colour television uses red, green and blue phosphors to create the various colours required to reproduce a colour picture.

4 Fig. 4.7 shows the inner workings of the type of a cathode-ray tube used in oscilloscopes. It has three main parts: an electron gun, a deflection system and a fluorescent screen, all ***housed*** in an evacuated glass enve-lope. This type of tube uses high voltages on the deflecting plates to change the path of the electron beam and to focus the beam into a small spot on the screen. This technique is called electrostatic deflection, as opposed to magnetic deflection which uses the magnetic field produced by a current passing through coils wound round the tube, used, for example, in most television picture tubes.

5 The electron gun comprises a heated tungsten filament within a nickel cathode cylinder coated with oxides of barium and strontium which give off electrons – a process known as **thermionic emission**, which was widely used in the (now almost obsolete) valve.

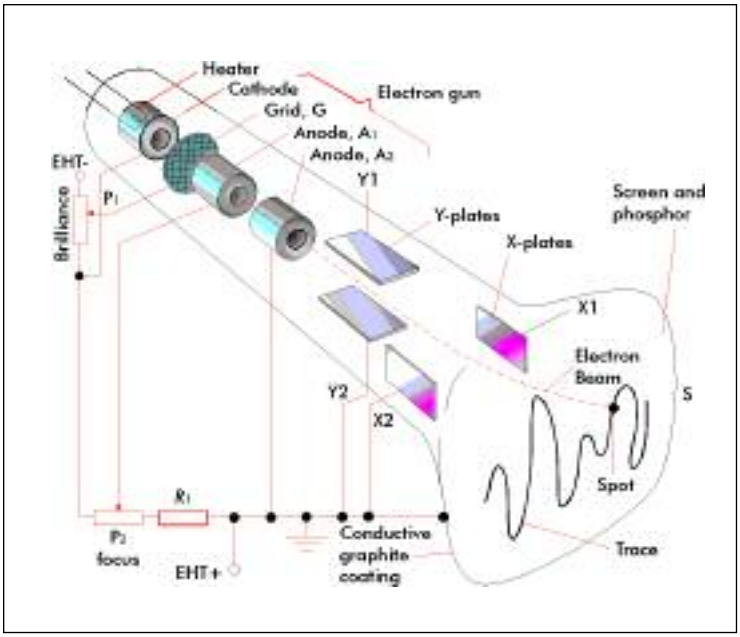

Fig. 4.7 *The operation of a cathode-ray tube*

The electrons are negatively charged so they accelerate towards the anodes A_1 and A_2 which are at a more positive voltage than the cathode. The strength of the electron beam, and hence the brightness of the image on the screen S, is controlled by the potentiometer P_1, which makes the grid more or less negative with respect to the cathode. The rest of the electron gun consists of accelerating and focusing anodes which are shaped metal cylinders, all held at a positive voltage which can be varied to alter the size of the spot produced on the screen. For a small CRT, the positive voltage on the focusing anodes is between 500 V and 1000 V. It is ***therefore*** dangerous *to* ***fiddle*** about with the circuits inside an oscilloscope – or a television, for that matter – unless you know what you are doing! A graphite coating inside the CRT avoids the build-up of electrical charge on the screen by collecting any secondary electrons given off by the screen.

6 After leaving the electron gun, the electron beam enters the deflection system which consists of two sets of metal plates, X and Y, at right angles to each other. The voltage applied to the X-plates is generated by a **time-base** circuit. Its job is to deflect the electron beam horizontally to make the spot "sweep" across the screen from left to right at a steady speed. The speed can be adjusted by the time-base controls on the oscilloscope. After each sweep, the time-base amplifier switches off the beam and sends it back to the starting point at the left end of the screen – this process is known as **flyback**.

7 The waveform to be examined on the CRO is amplified and applied to the Y-plates. The amplification of the waveform can be adjusted by the Y-sensitivity controls. The input waveform causes the horizontal trace to move vertically in response to the strength of the waveform. A stable trace appears on the screen when each horizontal sweep of the trace starts at the same point on the left of the screen. This is achieved by feeding part of the input waveform to a trigger circuit. This starts, i.e. triggers, the time-base circuit when the input signal has reached a particular amplitude set by the trigger level control. Most CROs allow manual and automatic adjustment of the triggering of the time-base.

(from "*Teach Yourself Electronics*", pagg. 45,46,47,48)

a. *Here are some answers, ask the questions*:

1. It's an instrument used to measure the characteristics of both d.c. and a.c. voltages. (par. 1)

2. To design and develop amplifiers, music synthesisers, televisions and many other electronic devices. (par. 1)

3. So that they can work outdoors. (par. 1)

4. A cathode-ray tube. (par. 2)

5. By moving the electron beam following the signal waveform. (par. 2)

6. Different colours of light. (par. 3)

7. Three main parts: an electron gun, a deflection system and a fluorescent screen. (par. 4)

8. To change the path of the electron beam and to focus it into a small spot on the screen. (par. 4)

9. The difference is that the magnetic deflection uses the magnetic field produced by a current passing through coils wound round the tube. (par. 4)

10. A heated tungsten filament within a nickel cathode cylinder. (par. 5)

11. To avoid the build-up of electrical charge on the screen. (par. 5)

12. They are aligned at right angles to each other. (par. 6)

13. After each sweep. (par. 6)

14. By the Y-sensitivity controls. (par. 7)

15. A stable trace. (par. 7)

b. *Describe orally the processes known as Thermionic emission (par. 5) and Flyback (par. 6).*

c. *Discuss in pairs*:

The passage gives you a few examples of the practical uses of an oscilloscope.
- In which paragraph are they mentioned?
- Make a list of them and add any other examples you can think of.

d. *Look at these words*:

"fires" (par. 2); "write" (par. 2); "echo" (par. 3); "sweep" (par. 6);

- They have been put in inverted commas in the text. Why?
- Would you consider them "technical terms"?
- Translate them into Italian from context; then look the words up in your dictionary.

e. *Match each word with its opposite*:

1.	rapidly	**a.**	specifically
2.	generally	**b.**	horizontally
3.	full	**c.**	similar
4.	incorporates	**d.**	leaves
5.	inside	**e.**	low
6.	different	**f.**	modern
7.	high	**g.**	darkness
8.	obsolete	**h.**	incomplete
9.	brightness	**i.**	variable
10.	enters	**j.**	excludes
11.	steady	**k.**	outside
12.	vertically	**l.**	slowly

f. *Try to understand these words/phrases from context (they are in bold character in the text); afterwards, check them in your dictionary.*

WORD	MEANING FROM CONTEXT	MEANING FROM DICTIONARY
versatile (par. 1)	.....	.....
portable (par. 1)	.....	.....
in sympathy with (par. 2)	.....	.....
though (par. 3)	.....	.....
housed (par. 4)	.....	.....
therefore (par. 5)	.....	.....
to fiddle (par. 5)	.....	.....

g. *The final paragraph of the text you have just read is given below. Complete the gaps using the following words*:

since	control	clearly	this
frequency	also	covers	oscilloscope