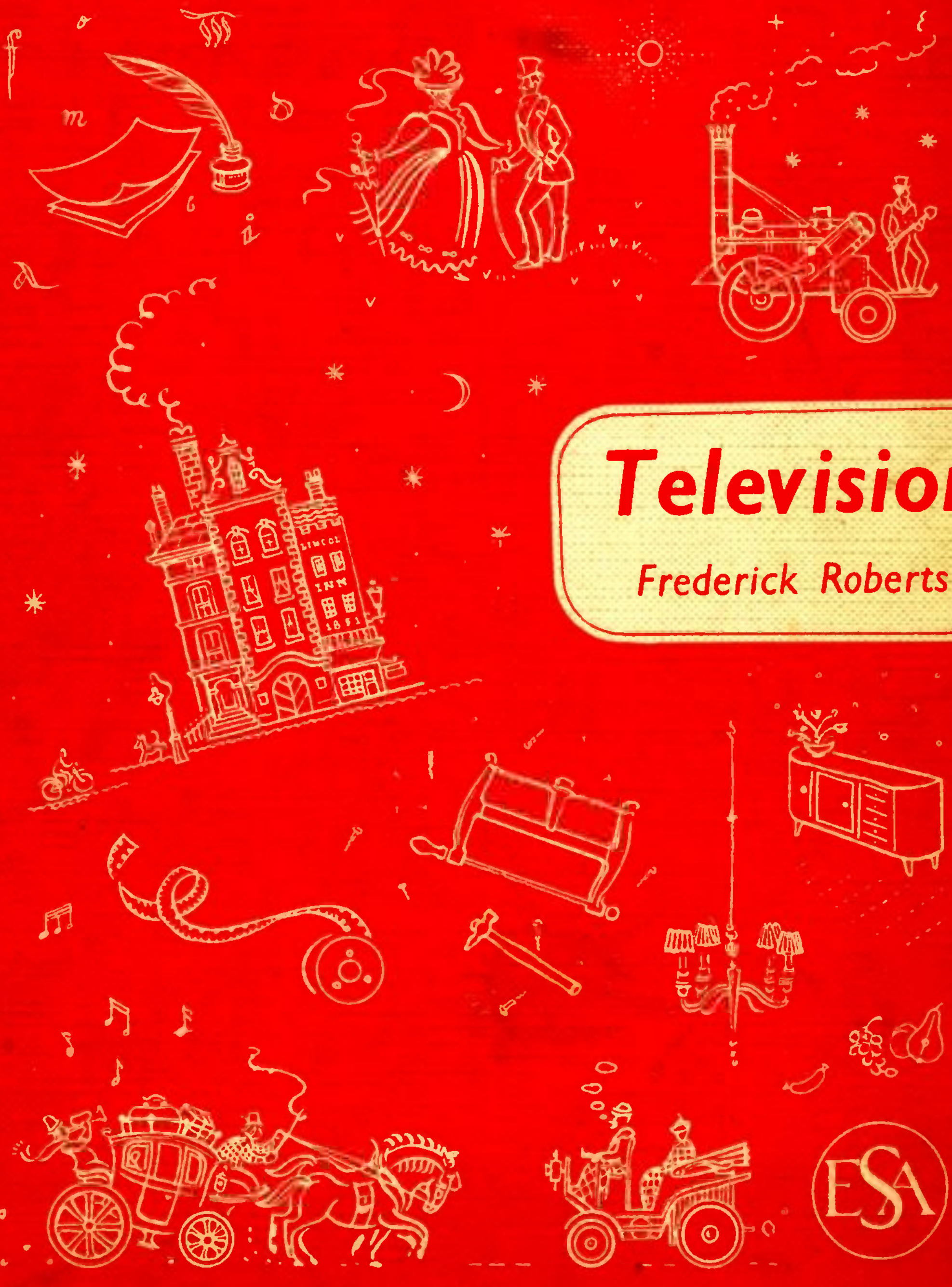
INFORMATION BOOK

HOW THINGS DEVELOPED

Television

Frederick Roberts



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World Radio History

HOW THINGS DEVELOPED

TELEVISION

Frederick Roberts

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INFORMATION BOOK

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World Radio History

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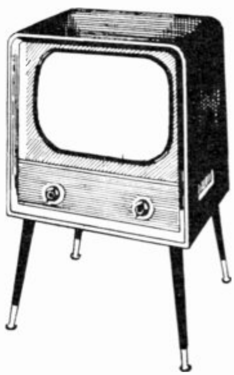


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CHAPTER ONE

Sending a Picture

HERE are six objects which are among the most important inventions of the last hundred years. The picture has been arranged in this way to show that there are certain things these inventions have in common. Before reading on see if you can say what these things are.

Looking across the picture on the first row we have a telephone, a radio, and a gramophone. These are linked by the fact that they are all concerned with *sound*. On the second row there are a TV set, a camera, and a cine-camera. These are all concerned with pictures, that is, with *light*.

Now, like a crossword puzzle, there are clues on the picture downwards. Telephone, radio, and TV set are used in *communicating* sound or light. Gramophone, camera, and cine-camera are used for *recording* sound or light.

The story of Television is in part the story of all these inventions. Just over a hundred years ago, none of them had been discovered. The farthest that one could communicate by sound was a few miles, by firing a gun, blowing loudly on a trumpet, or beating a drum. The only communication possible by light was between places within direct vision, by smoke or fires, flags or lamps. The only means of recording light was by drawing and painting, and of sound, by written words and music.

For thousands of years it had been like this, until in the nineteenth century, one after another, the discoveries were made. But

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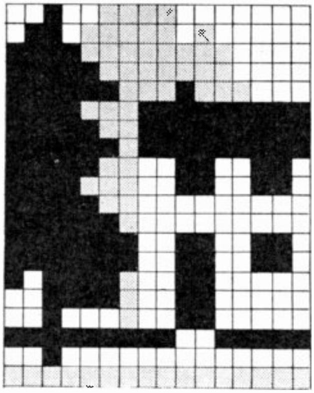
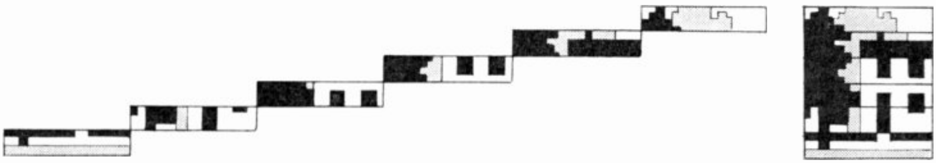


SENDING A PICTURE

'Dissection'-- the picture is divided into squares and sent line by line.

'Reconstruction'—the picture is reassembled line by line.



they were *not* discoveries of how to send or store actual light or sound.

We still cannot send actual light or pictures through space like postcards in the post. Actual sound does not travel through the telephone wires like water in a pipe, nor through the air to our wireless sets. Neither can we make records by shutting up light or sound in a box.

The telephone, the radio, and the gramophone are sound-making machines. They make *copies* of sounds which are being made far away or, in the case of the gramophone, which happened some time ago. We do not hear the original sounds.

The TV set and the film projector are light-producing machines, which make *copies* of scenes occurring in the present or which have occurred in the past.

Above is a picture drawn on graph paper, and so divided into

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squares. If we ask someone to go into another room, taking a blank piece of graph paper and a pencil, we can 'send' this picture to him.

We call out what is in each square, starting at the beginning, and remembering to say when we begin a new line. So that for this picture, we shall call:—1st line: square one, white; square two, white; square three, black; square four, white: etc. 2nd line—3rd line—and so on. Notice that we could not send the whole picture at the same time. We have had to take it to pieces, divide it up into strips, and divide the strips into squares.

Now what has the 'receiver' been doing? If he or she has properly received and understood our message we shall presently be shown the piece of graph paper marked with a copy of our original picture.

Strange as it may seem, this game we have been playing is a simple form of television. All television has the same kind of stages.

1. The picture is taken to pieces (dissection)
2. Facts about each piece of the picture are sent out as a *message* (transmission)
3. The message is received (reception)
4. A copy of the picture is made from the information contained in the message (re-construction).

The 'pictures' we have been thinking about so far have been little more than simple patterns. Now look at the right-hand pictures on page 4. You will see that it is entirely made up of white dots. In the light parts the white dots are larger: in the dark parts they are smaller, or disappear altogether. Hold the book at arm's length and you will get a better idea of the picture.

Look at the left-hand picture, and you will see another print of this photograph, but with a difference. If you look closely, you will notice that this too is made up of dots, only they are smaller, and there are many more lines of them to the picture. Both these pictures have been taken from the same photograph. You can see

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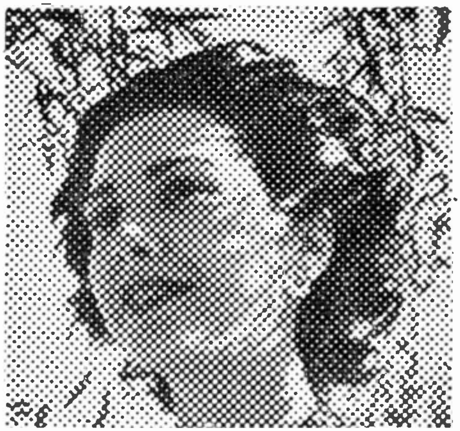

COARSE DEFINITION

Hold the book at arm's length to see the right-hand picture clearly. Then look at the same picture on the left. This is the same picture, but with many more dots to the inch, giving more detail.

now that if you build up a picture by means of dots, the more dots there are to the picture, the more detail you can see, and the clearer it becomes. In television language, this clearness is called 'definition'. The right-hand is a 'low definition' and the other a 'high definition' picture.

A Lamp Mosaic

We could make a picture by using dozens of electric lamp bulbs. Something like this is done in some illuminated advertising signs. To make the first picture in lights, we should need as many lamps as there are white spots. We need not use different sizes of lamps; we should have to arrange that the lamps acting as the large white spots should shine brightly, and for the smaller white spots the lamps should be dimmer. The advantage of this arrangement would be that all we would need do would be to control the amount of electric current each lamp received.

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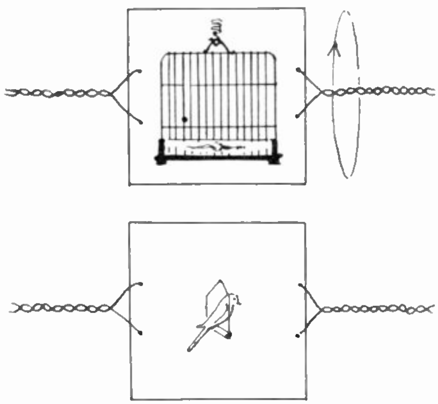
The Moving Spotlight

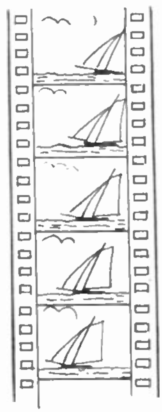
There is yet another way in which the picture could be built up in light, and that is by using a spot of light thrown on to a screen.

The spot of light could move across the screen and back again, zig-zagging backwards and forwards getting lower and lower till it reached the bottom. This action, similar to the movement of our eyes when reading, is called 'scanning'.

Whilst the spot of light was doing this it would have to be continually changing its brightness to make the shades of light and dark in the picture. If this whole scanning action were done very quickly indeed, covering the whole picture in a fraction of a second, and repeated continuously, our eyes would not be able to follow the moving spot, and we should apparently see the whole picture.

You may be able to see how this happens by using a mirror to throw a spot of light on a wall or the ceiling. Move the mirror very





EYE MEMORY

The cage is on one side of the card, the bird on the other. When the card spins round, the bird appears to be in the cage. Why ?

THE MOVIE FILM

Only one picture is seen at a time on the screen. The eye 'goes on seeing' the previous picture whilst the next is showing.

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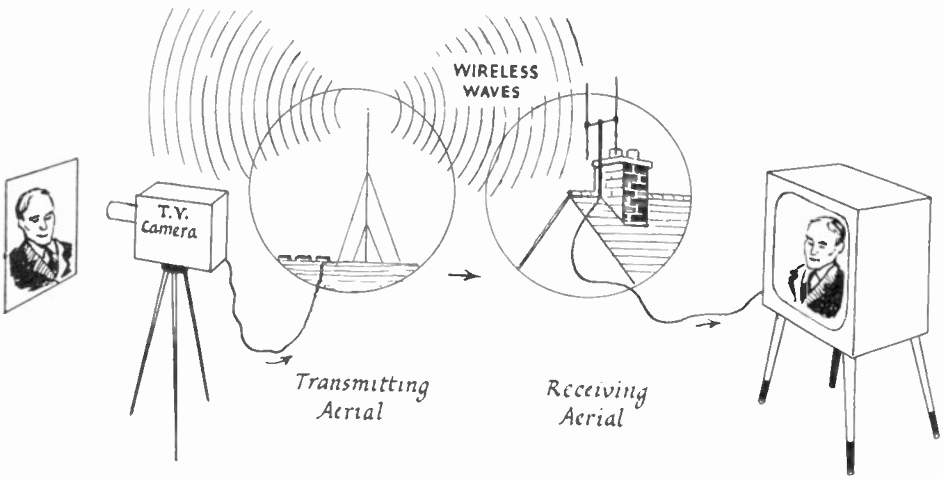
rapidly, so as to make the spot move to and fro in a straight line. If you do this quickly enough, the spot will appear as a line of light.

The reason for this is that the image of the spot seen by the eye lasts after the spot has moved. This effect is used by the cinematograph. The picture we see on the cinema screen is really a stream of pictures. Each of these is shown to us for a fraction of a second. The light 'blinks' for a fraction of a second while the next picture replaces the first. We do not notice this change because the image of the first picture lasts in the mind longer than it is actually showing.

Modern television uses the moving light spot and this power of the eye to 'remember'. The 'eye' of the T.V. camera only sees a tiny spot of the scene in the studio. It is made to 'scan' the scene or person being televised, starting at the top and very rapidly zig-zagging from top to bottom. It does this at a tremendous speed, covering the picture 24 times in a second, and making 405 zig-zags down the picture each time it does so! The camera sends out a



SEEING BY WIRELESS

The scene is televised line by line *very rapidly* at 405 lines per second. Because of 'eye memory' we see a complete picture in the receiver.

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message about what it is seeing. The message merely tells how bright the tiny fraction of the picture is that it is seeing at the particular instant.

This message therefore goes something like this: 'dim, dimmer, dark, very bright, dark, bright, . . .' only of course the message is not in words but in changing wireless waves.

At the other end the message is received. A tiny spot of light is moving across the screen in the receiving set in exactly the same way as the eye of the camera is moving, at the same speed, and with the same number of zig-zags. You can see the zig-zags as lines on the set screen if you look closely. The wireless 'message' received makes the spot of light grow brighter or dimmer, according to the spot the camera is seeing at that moment.

Thus a copy of the scene in the studio, built up by a moving spot of light, is shown on the screen of the T.V. set.

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CHAPTER TWO

The Light Cell

In 1816, a Swedish chemist named Berzelius discovered a new element, a previously unknown metal which he named 'selenium', or 'moon metal'. (An element is a single substance, not made up of a combination of other materials. For example, iron, gold, carbon, hydrogen, are elements. Water, chalk, etc. are compounds, that is, combinations of elements). The new element was added to the list, and its properties were examined and noted. It was not long before people were trying to use it for various purposes.

The nineteenth century was a wonderful period of discovery and invention. Perhaps in no other century in history have so many new things been discovered. Television depends upon electricity, wireless waves, and things like cathode-ray tubes and other devices to make it work. Its story is really the story of each one of these things. In this book, however, we shall deal with the people who first thought of ideas for television itself, and follow the development of these ideas until television became a reality. The time chart on page 100 is to enable you to follow the progress of electricity, photography, wireless, and the other inventions during this period. Please turn to it as the story goes on.

Photo-Electricity

In 1866, the first really successful trans-Atlantic telegraph cable was being laid from Valentia in Northern Ireland to Heart's Content, Nova Scotia. The engineer in charge of the electrical department of the cable laying was named Willoughby Smith. It

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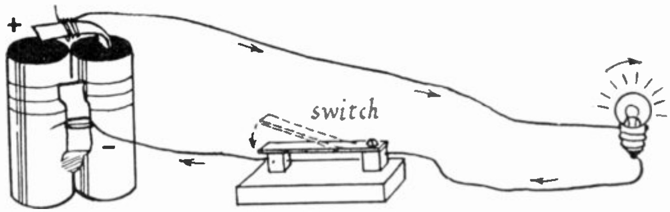
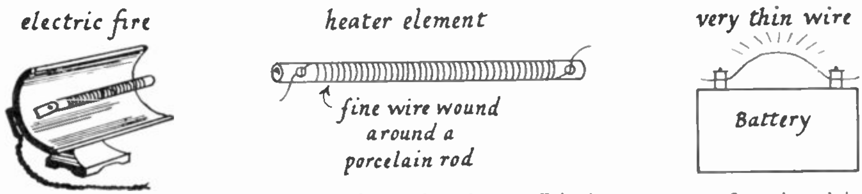
THE LIGHT CELL

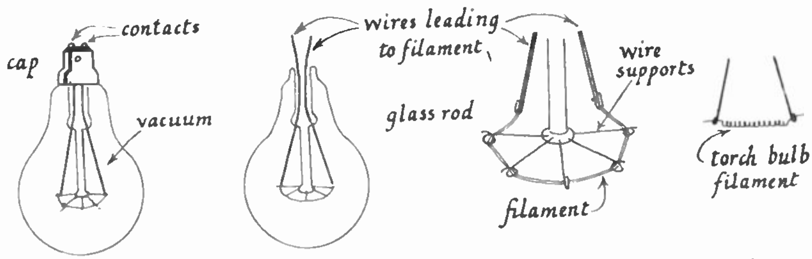
SOME ELECTRICAL IDEAS EXPLAINED



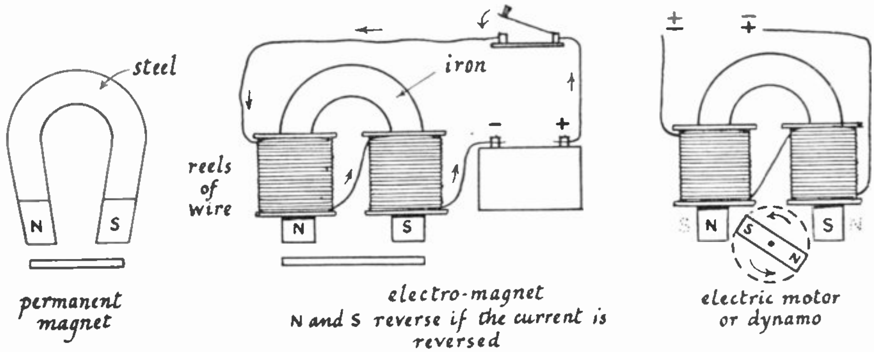
An electric circuit. The current flows out of the battery, through the lamp filament, through the switch, and back to the battery. The *direction* of the current is regarded as from the positive (+) terminal of the battery to the negative (—) terminal



Effects of an electric current (1) Heat. A thin wire gets hot when a sufficiently strong current flows through it.



Effects of an electric current (2) Light. A very fine wire is made white hot by an electric current passing through it. To prevent the wire burning away, it is enclosed in a vacuum in a glass bulb. Sometimes a gas is used to fill the bulb.



Effects of an electric current (3) Magnetism. An electric current flowing through a wire causes magnetism round the wire. The electro-magnet is magnetic *only while the current is flowing*. In the *electric motor*, a second magnet is made to spin round by continually reversing the current in the electro-magnet.

Generating an electric current. Just as an electric current can cause magnetism, so magnetism can cause an electric current. A moving magnet can cause an electric current in a wire. Hence if we spin the small magnet of the motor round, a current is generated in the coils of the wire. The motor then becomes a *generator*, or *dynamo*.

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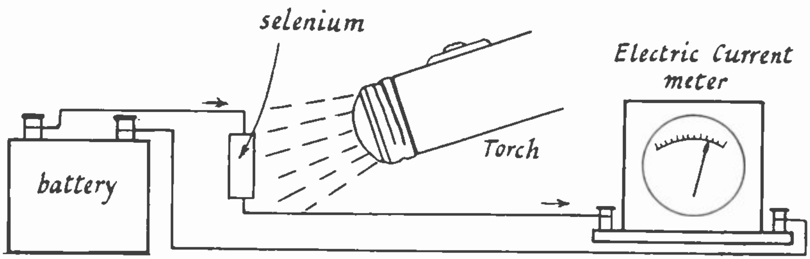
was arranged that the cable laying ship should be able to communicate with the shore station through the cable while it was being laid. To make this possible, some material having a very high electrical resistance was needed. Selenium was suggested to the engineer for this purpose, but at the same time he was informed that it was likely to be found unreliable.

Willoughby Smith obtained some specimens of selenium, and sent them to his works to be tested by his chief assistant, a Mr. May. The reason for the supposed unreliability was found. An electrical resistance, as its name suggests, is a material which 'resists' or reduces an electric current. So long as the bars of selenium were kept in a box which shut out all light, their resistance remained unchanged. But immediately they were exposed to light, their resistance diminished, and the electric current flowing through them increased.

Selenium was thus found to be sensitive to light. Willoughby Smith wrote about these tests to the Society of Telegraph Engineers of which he was a member. It was confirmed that selenium was 'photo-electric'. The more light that falls on it, the more electricity it will conduct. The possibilities of sending pictures electrically by means of selenium seem to have been realised quite soon after. May himself is said to have tried to make a machine for this purpose.

THE LIGHT CELL



Selenium lets more electric current pass through it when in the light than in the dark. This is the effect May noticed when sunlight shone on his instrument.

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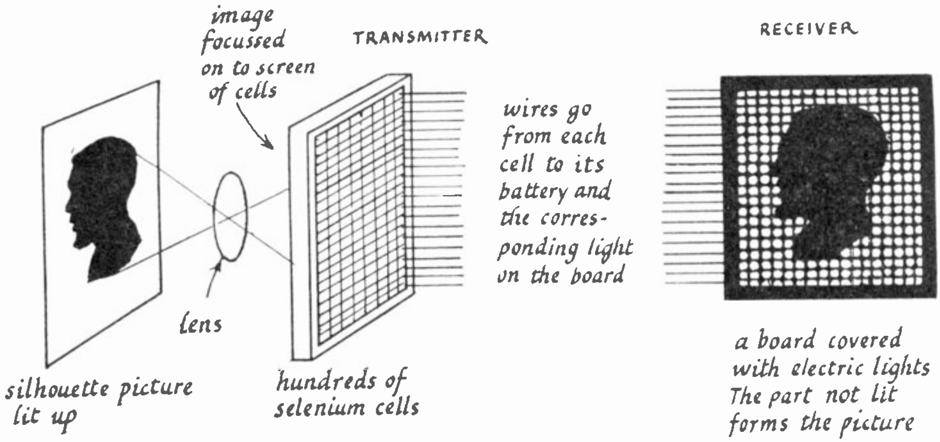
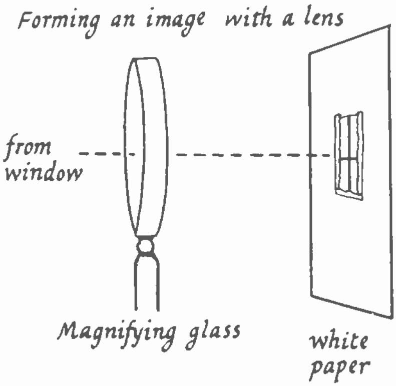


TELEVISION, 1880
This was the principle of Senlacq's second scheme, and Ayrton's and Perry's plan. (The picture would actually be upside down, because of the lens.)

The illustration shows one of the ways in which it was thought this sending of pictures could be carried out.

If we divide up a picture like that above into small squares, each small square is simply a patch of light or shade. The plan was to place opposite each one of these squares a small piece of selenium connected to a battery. From the pieces of selenium, wires would take the electric current to lamps arranged on a board.

Remembering that selenium is sensitive to light it can be seen that the current to each lamp would depend on the brightness of the different squares of the picture. The greater the current, the brighter the lamp would shine. So the whole of



FORMING AN IMAGE WITH A LENS
A bright image of the window or a lamp can be thrown on to a sheet of paper by means of a lens. The lens must be held a certain distance from the paper so that the image is in focus. The image appears upside down.

B

the lamps would give us a copy, in light, of the picture.

In the illustration, 'Television in 1880', the batteries are left out, for the sake of simplicity. A lens is shown, throwing an 'image' of the picture on to the pieces of selenium, which are arranged in cells like a honeycomb or mosaic. By using a lens, a scene could be focussed on to the cells, and sent like a picture.

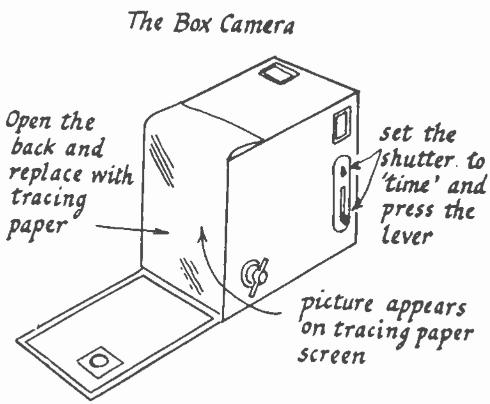
The 'Telectroscope'

As electric lamps were not invented until 1880, the first machines thought of for sending pictures were devices which *drew* the picture being sent. Such a machine was the 'Telectroscope', designed by M. Senlacq of Ardres. An account of this invention was given in the magazine 'English Mechanic' in 1878.

It is very interesting to note that M. Senlacq used the idea of 'scanning' in his machine. Looking again at 'Television in 1880', we can see that an enormous number of wires would be required to send a picture from one place to another by such a system. M. Senlacq's device was more practical.

The diagram on page 13 shows that he had an arrangement something like a box camera. For a screen it had a piece of ground or 'frosted' glass on which the picture was thrown by the lens. Over this glass, moving backwards and forwards from the top to the bottom, was a single piece of selenium. From this, just two wires ran to the receiver.

M. Senlacq's receiver *drew* the picture with a 'tracing point of blacklead or pencil for drawing very finely'. The pencil was made to move



THE BOX CAMERA
An image of what is 'seen' by the camera is thrown by its lens on to the film. By placing tracing paper in place of the film, you can see the picture.

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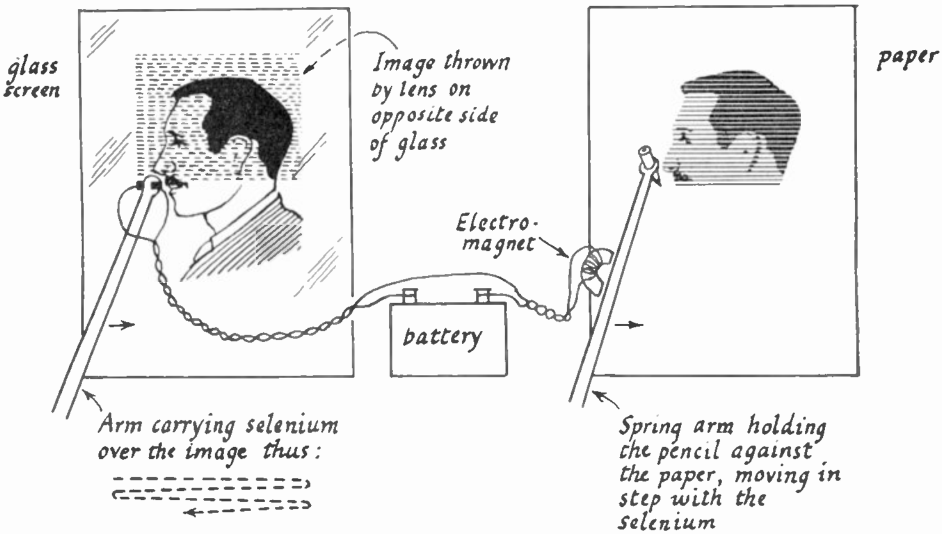

'THE TELECTROSCOPE'

The pencil pressure is controlled by the current flowing in the electro-magnet which *lifts* the pencil against the spring. A lighter part of the picture sends more current through the selenium, causing a lighter pressure in the pencil.

back and forth over a sheet of paper, keeping in step with the piece of selenium scanning the picture. The varying electric current from the selenium caused a mechanism to *press* the pencil as it moved. The picture was thus drawn in lighter or heavier lines of shading.

'*Seeing by electricity*'

Later on, in 1880, M. Senlacq suggested an alternative scheme. Instead of drawing the picture, he proposed to re-create it in light, on a screen. This time, he used a mosaic of selenium cells, on to which he focussed his picture by means of a lens. For his receiver, he now had a screen made up of sections, the same number as there were selenium cells. In each section was a fine piece of platinum wire, which was to glow when an electric current passed through it. The idea was much the same as that shown in

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'Television in 1880' except that once again M. Senlacq used scanning.

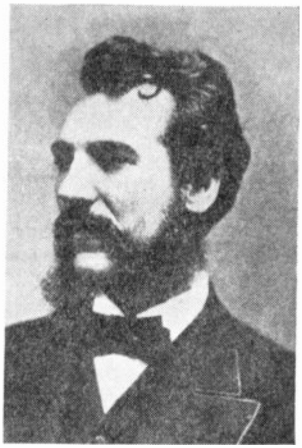
The selenium cells were switched on *one at a time* by a large sliding switch. The platinum wires in the receiver were also switched on one at a time by a similar switch, the two switches keeping in step. So that at any one time only one cell and one light were working together.

The scanning process was supposed to be carried out very rapidly, the picture being covered in a fraction of a second. Through 'eye memory' the viewer would apparently see the whole picture.

It does not appear that M. Senlacq ever constructed his apparatus. If he had done so, he would have found great difficulty in making it work. The 'English Mechanic' however, optimistically reported: 'The picture is therefore reproduced almost instantaneously. We can obtain a picture of a fugitive nature, it is true, but yet so vivid that the impression on the retina (eye) does not fade'.

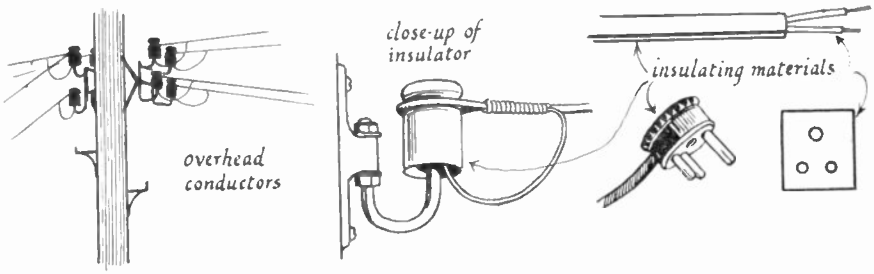
Later on, in 1881, the same magazine tells us that M. Senlacq's ideas 'everywhere occupied the attention of prominent electricians who have striven to improve upon them'. It continues, 'Amongst these we may mention Messrs. Ayrton and Perry, Sawyer (of New York), Sargent (of Philadelphia), Brown (of London), Carey (of Boston), Tighe (of Pittsburgh), and Graham Bell himself'.

There had been a rumour, the year before, that Alexander Graham Bell, (the inventor of the telephone) had also invented a process for 'seeing by telegraphy'. Ayrton and Perry, the two English 'electricians' mentioned above, wrote to the scientific publication 'Nature', to say that many

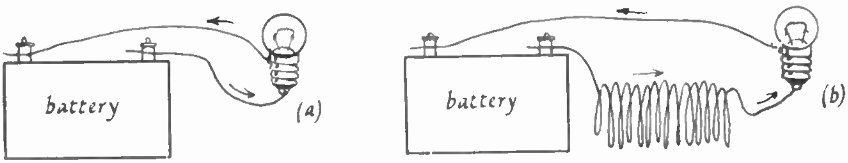


Alexander Graham Bell, inventor of the telephone

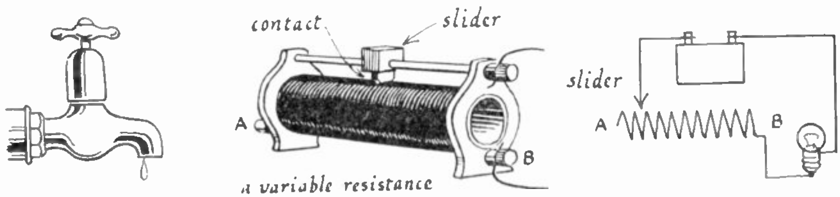
MORE ELECTRICAL IDEAS EXPLAINED



Conductors and insulators. Some materials allow electric currents to pass through them more easily than others. For example, silver, copper and aluminium are better conductors than iron and lead. Silk, rubber, porcelain, and certain plastics are bad conductors, and are called insulators.



Resistance. A good conductor is said to have 'low resistance' to an electric current. Copper therefore has less resistance than iron. Also a long, thin wire has more resistance than a short thick one. Less current will flow in circuit (b) than in circuit (a).



Controlling the current. The watertap controls the flow of water by opening or closing. A method of controlling the flow of electric current is by varying the resistance in a circuit. The diagram shows a variable resistance used for dimming a lamp. When the slider is at A, resistance is greatest, and the current least.

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people had devised systems of seeing by telegraphy, before Bell. They went on to describe their own systems, which they said had been inspired by a picture in 'Punch' three years before and followed Willoughby Smith's discoveries.

They also had the idea of a large mosaic screen of selenium cells at the transmitter. Each cell was connected to a battery and a telegraph line. The receiver had a screen with as many openings in it as there were selenium cells. Behind this screen was a light. In front of the openings were magnetic needles or pointers which could open or close them, to let pass varying amounts of light. The current from the selenium cells, coming along the connecting wires was expected to move the pointers, thus giving a picture in lights. As an alternative, Ayrton and Perry suggested a receiver screen made up of a large number of movable metal reflectors, each of which could be made to turn by the electric currents from the selenium cells.

Ayrton and Perry did not therefore include scanning as part of their design. G. R. Carey of Boston, Mass., U.S.A. proposed two ideas which appeared in 'Design and Work' in 1880. Both were concerned with *printing* the received picture by chemical means. One used a selenium cell mosaic at the transmitter, and like Ayrton and Perry's schemes, employed no scanning. The other resembled Senlacq's first scheme, the scanning being carried out by a selenium cell moving in a spiral, driven by clockwork. A similar scanning mechanism was used in the receiver, but Carey apparently forgot to make any arrangements to keep both sets of scanning in step.

Shelford Bidwell

Like Senlacq, neither Ayrton and Perry, nor Carey, nor indeed most of the 'inventors' of seeing by telegraphy at this time seemed to have tried out their ideas in practice. An exception, however, was the English scientist, Shelford Bidwell. His apparatus is in the Science Museum, South Kensington, and is illustrated on page 17. It was successfully demonstrated to the members of the Royal

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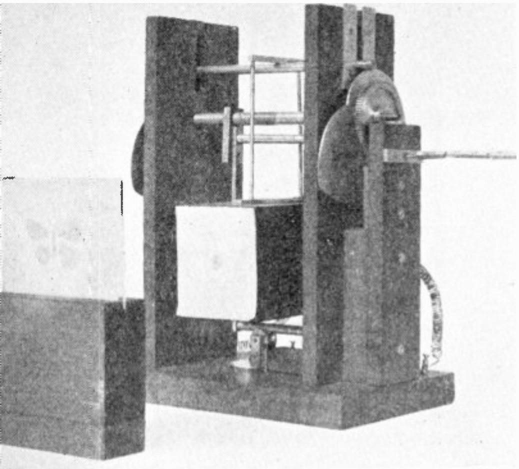

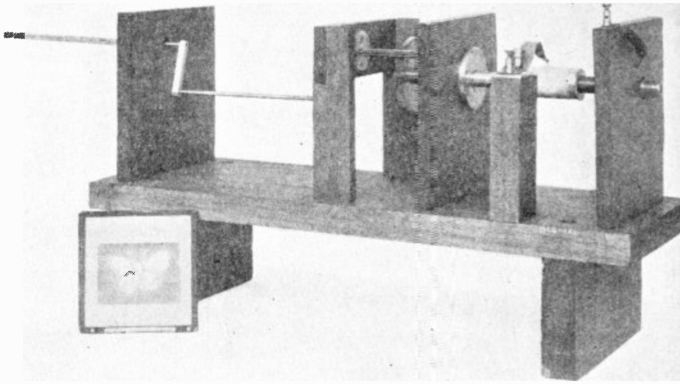

Shelford Bidwell's 'Picture Telegraph'; the transmitter and the receiver. Both pieces of apparatus were connected together by the long shaft. A copy of the picture received is in the frame in front of the receiver.

Institution, the Physical Society, and the British Association for the Advancement of Science. He seems to have constructed it about the year 1881. It was a machine for transmitting pictures over a wire to a receiver where they were printed line by line. The scanning mechanism was very ingenious.

At the sending end, an image of the picture was focussed on to the front of a box. The front of this box had a tiny hole like a pin hole in it, behind which was a selenium cell. The mechanism raised the box up and down vertically. A screw moved the box along slowly sideways. Thus the pinhole was carried in a zig-zag motion across the image—scanning it.

At the receiver, a platinum point pressed on a sheet of paper which was soaked in potassium iodide and wrapped round a cylinder. The cylinder rotated and the point moved along keeping exactly in step with the pinhole in the box of the transmitter. The platinum point was connected to the selenium cell.

The picture thus appeared, gradually built up of parallel brown lines, caused by the electric current in the platinum which affected the potassium iodide and turned the paper brown. The stronger the current, the darker the brown line. Consequently, the light and dark parts of the image were reproduced in the picture.

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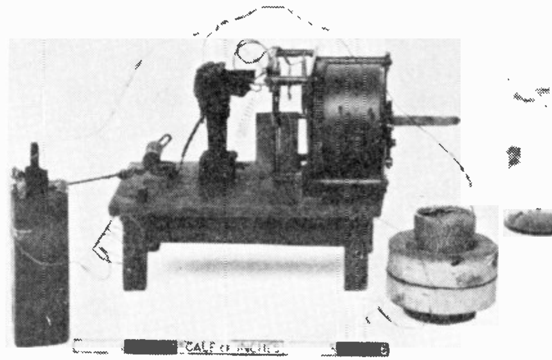
Bell's telephone (1876)



David Hughes' microphone (1878)

A Frenchman, Maurice Leblanc, suggested a form of scanning using a mirror. The mirror vibrated up and down rapidly and turned from side to side slowly at the same time, thus covering the image. The reflection from the mirror as it vibrated was focussed on a selenium cell, causing a varying electric current which could be sent along a line as in the previous ideas. The scanning method was very efficient. Unfortunately attempts to use it failed because of the difficulty of making the mechanism in the receiver keep exactly in step with it.

Thus, by the year 1880, or thereabouts, the basic ideas of television mentioned on page 3 had been thought of. Some of the inventions were really concerned with printing pictures by telegraphy, rather than with television as we understand it. The two processes developed together for the next forty-five years, and we must follow both for part of the way. The principles of dissection, transmission, reception, and reconstruction apply to each of them.

So far, except for Shelford Bidwell's picture telegraph none of the ideas were put into practice. In the meantime, following the discovery of the effect of light on selenium, other important scientific events were taking place. Graham Bell invented the telephone about the year 1876. Two years later the microphone was invented by David Hughes. In 1888, Heinrich Rudolph Hertz was experimenting with wireless waves.

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CHAPTER THREE

Nipkow's Disc

In the 1880's, the word 'television' had not yet come into use. Instead, the idea was described by some such name as 'seeing by electric telegraph'. Into the story about this time comes another telegraph engineer like Willoughby-Smith. This was Dr. Paul Nipkow (pronounced 'Nip-kov'), a German who worked for most of his life as an engineer for a railway signal and telegraph company. In 1884, he patented an invention which he called an 'electric telescope'.

We can best see how Nipkow's device worked by making a model of it, or at least of a simplified version of it. It is well known as Nipkow's disc, or scanning wheel, and marks an important stage in the television story, because the very first practical television systems depended on it. Unfortunately for Nipkow, the idea was about thirty years ahead of its time.

The diagram overleaf shows a cardboard wheel which can be spun round rapidly. In the cardboard are a number of small holes arranged in a spiral, so that successive holes are closer to the centre. The rest of the model can be built of wood or Meccano parts. The wheel can be turned by hand, or it can be driven by a clockwork or electric motor.

When you have completed the model, you can see how it is used, firstly for 'dissecting' a picture and secondly for 'reconstructing' the picture at the receiving end. Both actions are

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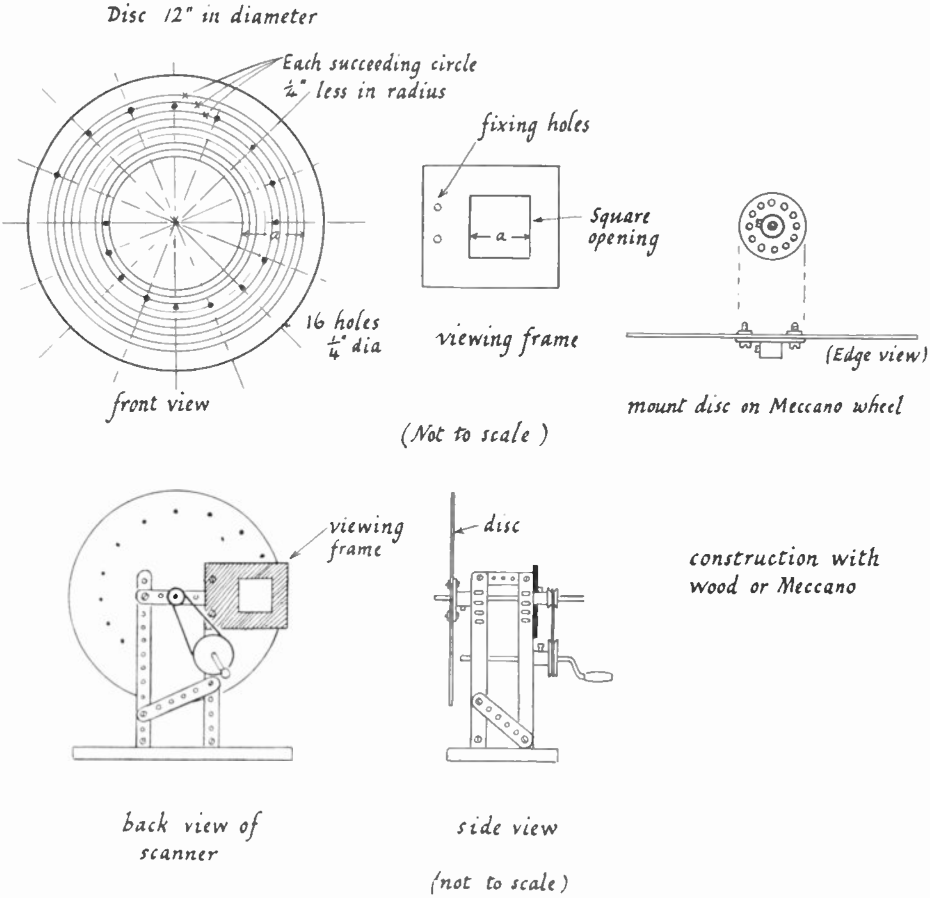

A NIPKOW DISC

A 16-hole model you can make yourself to try the experiments in this chapter. The disc and viewing frame can be made in cardboard or thin plywood.

similar, but let us first see how the scanning disc takes a picture to pieces.

For a picture, we can use a simple pattern or a letter of the alphabet. The important thing is that it should be very bold and clear, preferably in black and white. Pin the picture on to the wall or a drawing board and arrange it so that it is brightly illuminated

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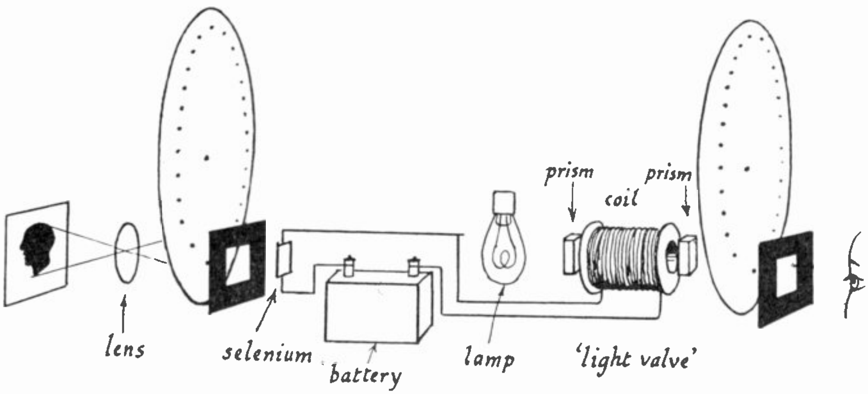
by daylight or a good size electric lamp. Place your model Nipkow disc in position and notice what happens when you look into the viewing frame. Turn the handle slowly clockwise.

As you will observe, the holes pass one by one, over the picture from top to bottom, each successive hole coming to the left of the one before it. The picture has thus been divided into as many strips as there are holes in the disc. The scanning is vertical instead of horizontal in this case.

If you were able to place a selenium cell instead of your eye before the viewing frame, the electric current passed by the cell would commence to vary according to the amount of light coming from each hole as it passed by.



NIPKOW'S 'ELECTRIC TELESCOPE'

Instead of varying the light of the lamp, the electric current from the selenium operates the 'light valve' which varies the amount of light passing through it.

The 'Electric Telescope'

Dr. Nipkow's 'electric telescope' was an idea for sending pictures along wires. He suggested one disc for dissecting the picture and sending the current from a selenium cell along a pair of wires. At the end of these wires the current controlled the amount of light which shone through a second Nipkow disc into a viewing frame.

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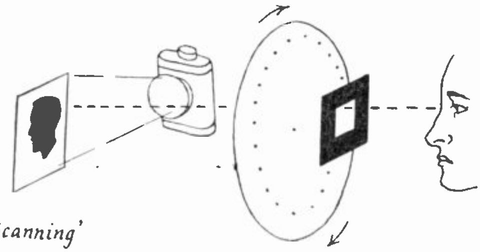

'Scanning'

Provided that both discs started with their holes in the same position and commenced together, running at exactly the same speed, the picture would be put together again in the viewing frame.

We can get an idea of the action of reconstruction if we use our model in a darkened room with a small electric lamp, such as a cycle lamp, shining on the picture. It is a good plan to diffuse the light from the cycle lamp by putting a piece of tracing paper over the glass. Point the lamp at the picture on the opposite side to the viewing frame. Now turn the wheel slowly whilst looking into the frame. Spots of light begin to descend at one side of the frame, moving gradually across until the wheel has turned once, then beginning at the other side all over again. So far, we see only moving spots.

Now turn the disc rapidly, and keep on turning. You will now see a shape which is nearly a rectangle of light, filling the frame. This effect is due to 'persistence of vision', or eye memory (see pages 5 and 6). If you look at a bright light, and then turn away, you will still see it for an instant afterwards. Were it not for this fact neither the cinema nor television would be possible, as was mentioned in Chapter 1.

As we have no selenium cell we cannot perform the experiment of trying to send the picture along wires. If we could, we should find the same difficulty which made Nipkow's apparatus, as it stood, of so little use for television.

The persistence of vision, or 'memory' of our eyes is only for a small fraction of a second. If we are to see a whole picture instead of just a number of moving spots, the eye must be able to 'remember' the first spot by the time that the last one moves. This is the same as saying that the whole of the spots making up a picture

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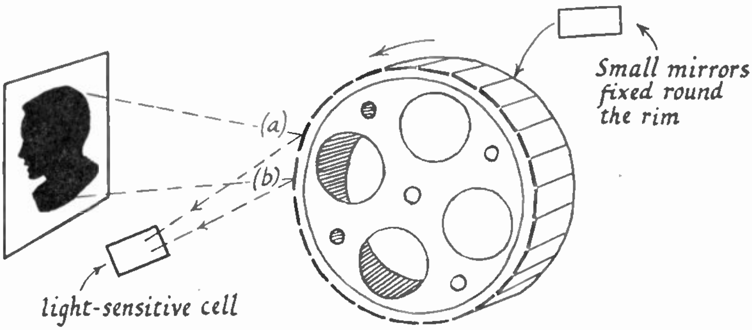
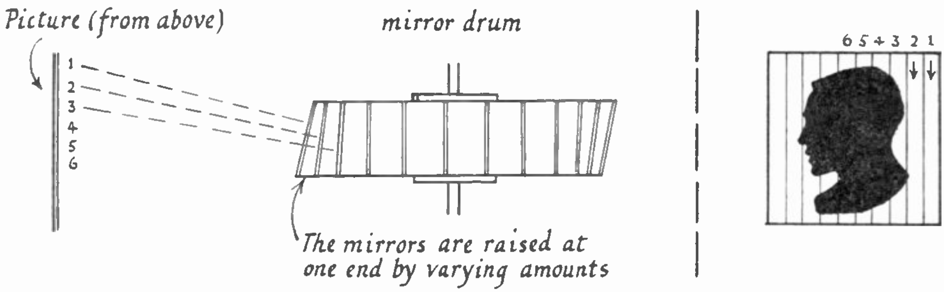
must appear one after the other, in the space of a *fraction of a second.*

The trouble was that the selenium cell could not act quickly enough to change the electric current in the fraction of a second during which each spot travelled over it. Another difficulty was that not enough variation in the electric current could be caused by the selenium to make the light change in brightness to any extent. Because of this, pictures sent by Nipkow's system could only appear like grey shadows, with no detail at all.





WEILLER'S MIRROR DRUM (1)

Part of the picture will be reflected in mirrors (a) and (b). When the drum turns, each mirror scans the picture from top to bottom. The light cell is placed where it can catch the reflection from each mirror as it descends.

WEILLER'S MIRROR DRUM (2)

The mirrors are tilted on the edge of the drum so that each reflects a different vertical strip as it goes round. The picture is thus scanned in as many strips as there are mirrors (shown on the right).

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Nevertheless, the quest for television went on, and people continued experimenting with scanning, and trying to find improved methods. Such an experimenter was L. Weiller, who in 1889 produced an alternative to Nipkow's disc in the form of a cylinder or 'drum' covered with tiny mirrors. These were set at different angles so that, as the drum was revolved, each part of the picture was reflected in turn on to the selenium cell. Weiller's mirror-drum was also employed later in the first television systems.

The Photo-Electric Cell

By 1900, scientists who had been following up the work of Heinrich Rudolph Hertz had been successful in sending and receiving wireless waves over short distances. This was taking place in laboratories in many countries where the scientists were interested in finding out more about the waves and what connection they had with visible light. So far nobody had yet suggested using wireless waves for any purpose, such as telegraphy.

Other experiments of Hertz had led to the development of the *photo-electric cell*, which had now replaced selenium in television experiments. The type of photo-electric cell so used caused an electric current to flow when it was exposed to light. Unlike that of selenium, its action was practically instantaneous. The current it produced, however, was very small.

In New Jersey, America, Thomas Edison, who had invented so many things, including the gramophone, was now experimenting with moving pictures and the cinefilm was about to be invented.

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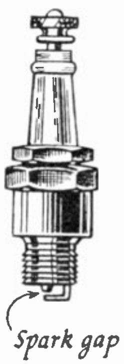
CHAPTER FOUR

Cathode Rays

THE people who first experimented with electricity soon found that it could cause *sparks*. They found that sparks could be produced by electricity generated by friction. They also discovered that sparking took place when the wires from a large battery accidentally came together. Benjamin Franklin flew a kite in a thunderstorm and obtained sparks from the end of the string. This made him conclude that lightning itself was a huge electric spark.

In *Wireless*, the companion book to this one, you can read how the closer study of electric sparks led to the study of wireless waves. The first wireless waves generated by man were created by devices which made electric sparks, and Marconi's first wireless telegraph used a spark transmitter.



The motor engine sparking plug.

The careful study of electric sparks also helped in the development of television. If wires carrying electricity at a high pressure (voltage) are brought closer and closer together, a spark will leap across when the gap between them is small enough. In the sparking plug of a motor car engine two metal points are arranged sufficiently close together for a spark to leap across when a high voltage is applied to them.

The reason for the spark is that the high voltage causes the *air* in the gap to conduct the electric

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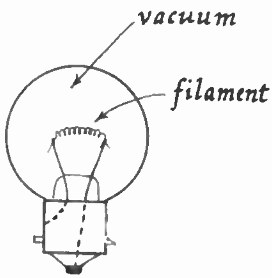
current, and to heat up to a tremendously high temperature as it does so.

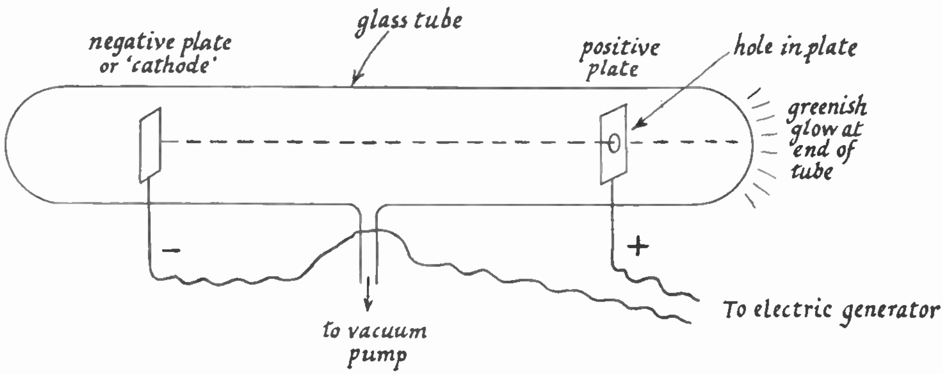
The 'Crookes Tube'

In 1878, some scientists were beginning to experiment with electricity *in a vacuum*. One interesting result of this was the invention by Joseph Swan of the first electric lamp of the kind we use today. This is a fine wire or filament sealed up inside a glass bulb from which all the air has been pumped. Because the air is removed, enough electric current can be passed through the thin wire to make it white hot without the wire burning away. Swan's lamps, besides being useful for illumination, also led to the invention of the wireless valve.



The electric lamp
A modern version of Swan's lamp

In the same year of Swan's invention, another scientist, Sir William Crookes, was experimenting with electric sparks in a vacuum. His discoveries take us yet a stage further in our television story. The diagram shows a glass tube, closed at each end, with a

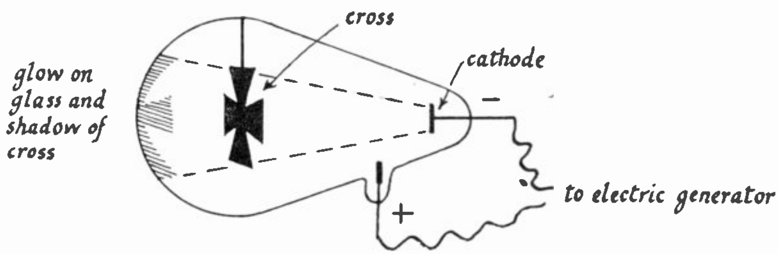


CATHODE RAYS (1)
Crooke's experiment with electricity in a vacuum

small tube leading from it to a pump which can remove all the air. Near each end of the glass tube are metal plates connected to wires which lead to a supply of electricity. If these were plates in air, they would be too far apart for a spark to leap from one to the other unless a really enormous voltage were employed. (In air, we need about 20,000 volts to make a spark leap across a gap of 1 centimetre, and for a larger gap an even higher voltage). But in a vacuum, things happen differently.

Crookes applied a few thousand volts to the plates of his tube, and set the pump working to remove the air. As he did so, he noticed some very strange effects. When only a little of the air remained, a long thin zig-zag 'spark' joined the plates. As the pumping went on, and the air grew still less, this long spark widened out into a bright glow filling the tube. At the next stage, a sudden change took place; the bright glow began to fade, and dark spaces appeared at certain distances from the negative plate or 'cathode'. Around this cathode itself appeared a faint glow. When the vacuum was nearly perfect, the tube became almost dark again except for the glow round the cathode, and most important of all, a greenish 'fluorescent' spot of light appeared on the glass at the opposite end.

Even when a tube had the positive (anode) plate in a different position at the side of the tube as shown below, this fluorescent light spot still appeared on the glass directly opposite the cathode. *It*



CATHODE RAYS (2)
The invisible rays cause a glow on the glass. The little cross casts a shadow, showing that the rays are coming from the cathode.

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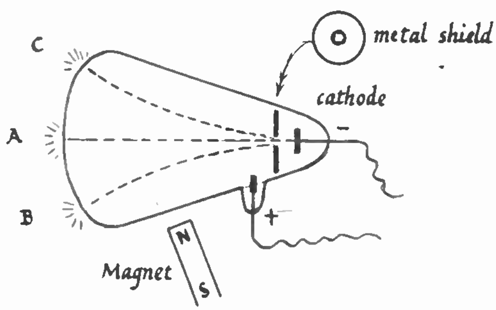
was as though an invisible ray were coming from the cathode plate to the spot where it met the glass.

An earlier experimenter, the German scientist Julius Plücker, had observed a similar effect in 1859. The invisible ray which could cause certain substances to glow, was later called a 'cathode ray'. The illustration on page 27 shows how we get further evidence that there is a ray of some kind present in the tube. When the electricity is switched on, the glass at the end of this tube glows, and although we cannot see the ray itself the little cross suspended in the tube throws a dark shadow on the glow at the end. If a tiny windmill of very thin foil is put in the place of the cross in the illustration, it will spin round showing that something is striking it and making it rotate.

The Cathode-Ray Tube

This 'something' is now known to be a stream of electrons or tiny electrical particles, shooting through space inside the tube in a beam from the cathode. The beam is invisible until it strikes certain kinds of glass and other materials which are called 'fluorescent'.

In 1897, a German, named Karl Braun, made a cathode ray tube, and coated the glass at the end with a 'screen' which glowed when the cathode ray fell on it. Braun made the important discovery that he could move the cathode ray about by means of a



BRAUN'S CATHODE RAY TUBE EXPERIMENT

The hole in the metal shield directs the cathode rays in a narrow beam, causing a glow at the spot A. When the magnet is brought near, the beam is deflected, and the spot moved to B. Reversing the magnet moves the spot to C. An electro-magnet or a coil carrying an electric current will deflect the beam in the same way.

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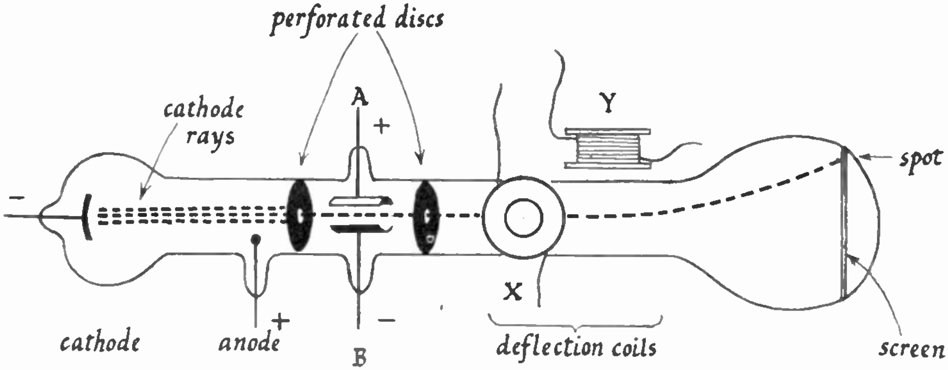
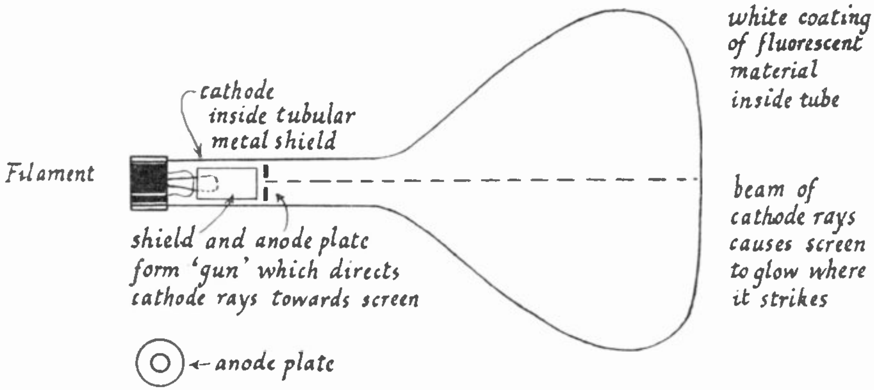


ROSING'S PATENT, 1907

The cathode ray tube of Rosing's receiver is shown. The beam is deflected up and down and from left to right by the coils Y and X. The brightness of the moving spot of light is controlled by plates A and B. The higher the voltage between these plates, the more the beam will be drawn upwards towards A, thus reducing the amount of rays passing through the holes towards the screen.

magnet, thereby causing the light spot to move about the screen.

This is how the cathode ray tubes of our modern television sets work. Braun however was only interested in the rays themselves, and as far as we know, did not suggest using his tube for television. The first person who thought of *this* use for cathode ray tubes was a



THE CATHODE RAY TUBE (1)

The modern version of Braun's tube as used in television receivers. The arrangements for focussing and deflecting the beam are shown in the next diagram.

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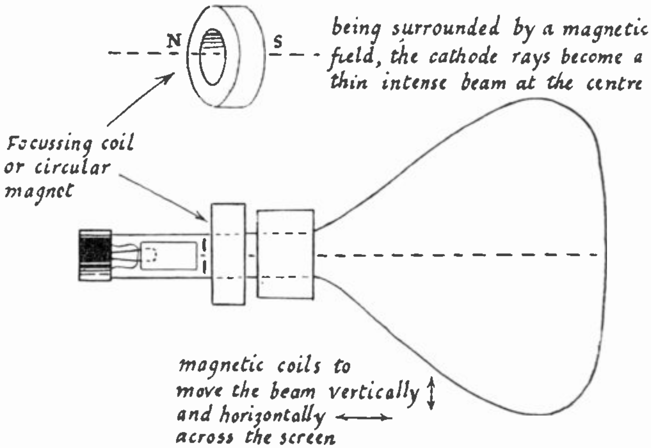


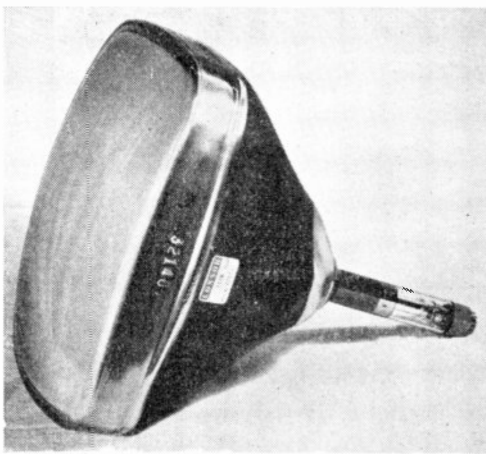
THE CATHODE RAY TUBE (2)

Arrangements for focussing the beam to a narrow pencil of rays and for moving the beam over the screen.

Russian scientist of St. Petersburg, named Boris Rosing. In 1907, he proposed the use of the cathode ray tube in a *television receiver.* His idea is used in receiving sets today: the cathode ray does the scanning and the picture appears on the screen at the end of the tube.

Rosing's transmitter used mechanical scanning with *two* mirror-drums of an improved design. Once again, in spite of the cleverness of the idea, Rosing's television system was unsuccessful. The changes of electric current from his photoelectric cells were too small, and the cathode ray tubes made in his day were too imperfect.

His work was carried on, however, to success by another Russian, his pupil Vladimir Zworykin, of whose work we shall hear in Chapter 10 dealing with the 1930's.



A modern cathode ray tube used for television reception

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CHAPTER FIVE

Wireless

By the year 1900, the motor car had been invented. Already motor vehicles of all kinds were appearing on the roads. In 1903, Wilbur and Orville Wright had equipped their glider with a petrol engine. The aeroplane began with their first flight which lasted just under a minute. The start of the new century saw also the beginning of the cinema, as we now know it.

Louis Lumière had invented the cinematograph in 1895. (See *The Cinema* in this series). Now, films were being shown in music halls all over Britain, France and America. Film studios were being built in Europe and America. In England, William Barker had built a studio at Ealing, beginning Ealing Studios. In France, Charles Pathé and Léon Gaumont were producing films. In America, William Fox, the Warner brothers, and Karl Laemle were at work. The 'picture palace' was beginning to appear in the towns.

G. Marconi, who first demonstrated the use of wireless waves for sending messages in telegraphy.

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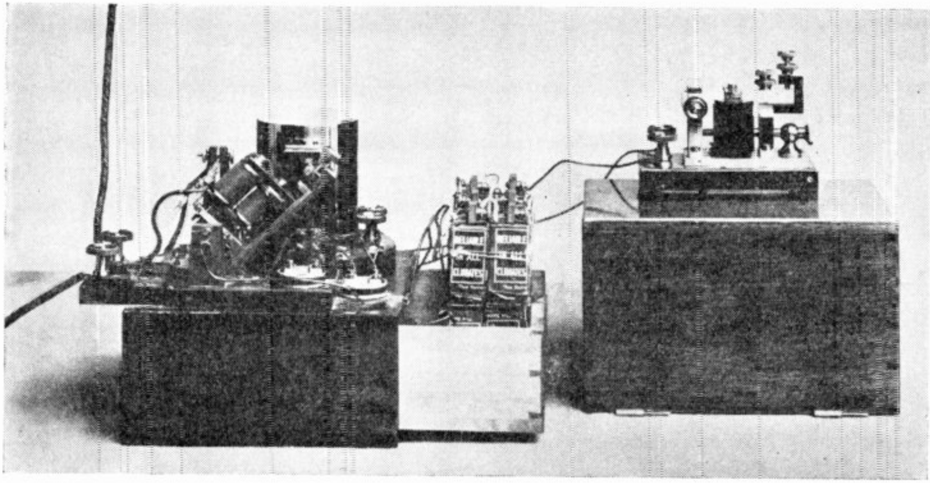

An relay wireless telegraphy receiver, showing the Morse tapper, which sounded the Morse signals as they were received

'Telegraphy without wires'

Wireless, also, had arrived by this time. A few years before 1900, Gugliemo Marconi had come to England bringing his ideas for 'a new system of telegraphy without wires'. In 1897, he had sent the first wireless message in history over three and a half miles in the Bristol Channel. Like so many other inventions of this time, wireless telegraphy made very rapid progress. Marconi increased the range of his apparatus to over thirty miles within a year. Three years later, lighthouses and light ships were being equipped with wireless so that they could communicate with the land. Messages across the English Channel soon followed, and in 1901, came the greatest advance of all when Marconi sent a message across the Atlantic.

In a few years regular wireless messages were being exchanged between stations in England and America. Similar wireless telegraph services commenced also between England and countries in Europe. Newspapers on both sides of the Atlantic were printing special reports received by wireless.

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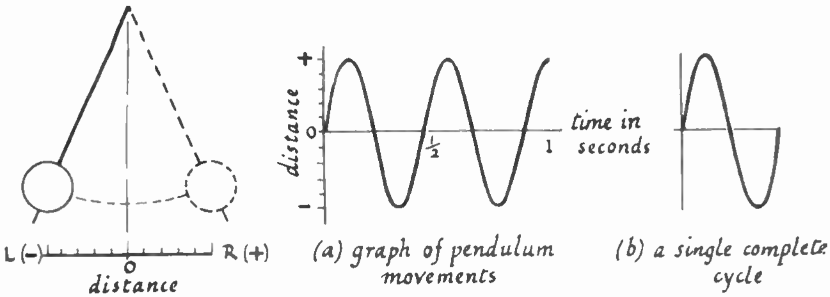
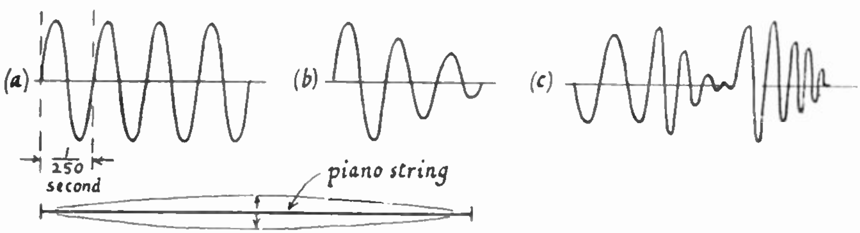


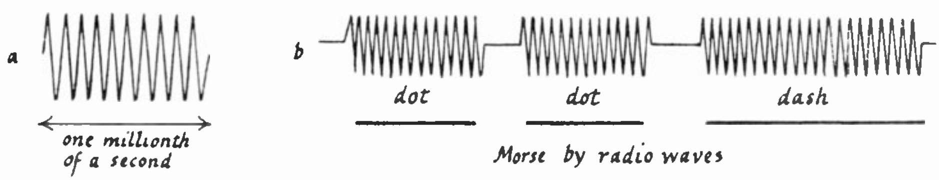
FREQUENCY

The graph (a) shows the movements of a pendulum, calling movement to the left − and those to the right + . (b) shows a single complete movement or cycle.



SOUND WAVES

(a) shows the vibration of a piano string producing sound waves. The frequency shown is one cycle to every 1/250th of a second, or 250 cycles per second. (b) shows a sound dying away. (c) shows a mixture of frequencies and loudness, corresponding to many of the sounds we hear.



WIRELESS WAVES

Wireless waves have frequencies much higher than sound. (a) is a representation of a frequency of ten million cycles per second (ten megacycles per second). (b) shows wireless waves being switched on and off to send a message in the Morse Code. The real number of cycles cannot be shown in the drawing. A radio wave used for carrying a message is called a 'carrier wave.'

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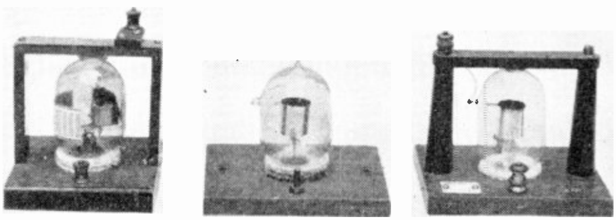
The Radio Valve

Up to this time, 'wireless' had meant *wireless telegraphy*, that is, messages in the Morse Code. The wireless operator used a Morse Key to send his messages. His 'receiver' consisted of a 'sounder' or buzzer which enabled him to hear the dots and dashes of the incoming messages. (The recorder or tape machine which printed these messages on a paper tape was also in use).

But although the telephone had been in use since 1881, the human voice had not so far been sent by wireless. The microphone had been invented by David Hughes in 1878. After the introduction of wireless telegraphy, attempts were made to use the microphone with the spark transmitter, but without success.

We now come to the great discovery which made *wireless telephony* possible—that is, the sending of voices, music, or sounds of any kind by wireless. This invention was the *valve*, which enormously increased the range of wireless transmission and reception.

The first valve was made by J. Ambrose Fleming, an English scientist and electrical engineer, who had helped Marconi for many years. Fleming had also experimented with electric currents flowing through wires in a vacuum. His first valve, invented in 1904, was a version of Swan's electric lamp with a metal plate suspended a little above the filament. By applying a high voltage between the filament and the plate, Fleming had discovered that an electric current would cross the space between. As in the case



Examples of Fleming's first valves (1904)

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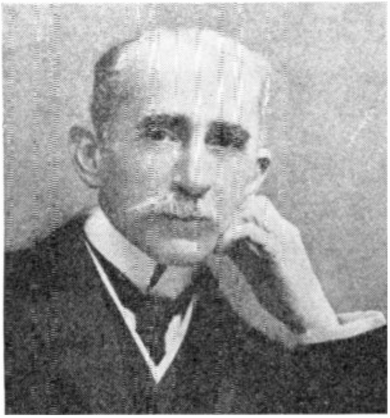


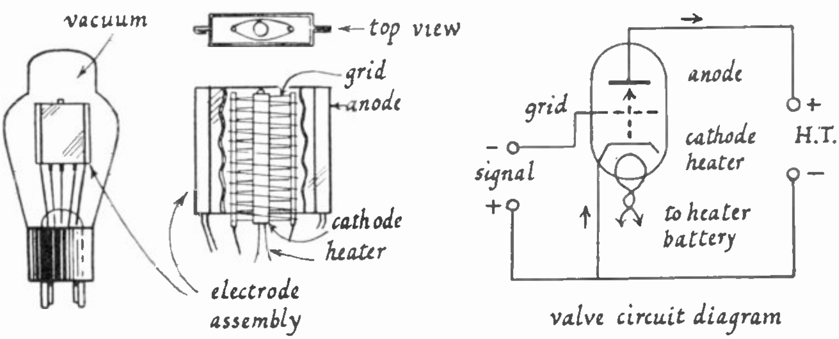
Sir Ambrose Fleming, the inventor of the wireless valve

of the cathode ray tube, a stream of electrons was reaching the plate, this time from the hot filament of the lamp.

Magnifying the Current

Fleming's valve was used in receivers, where it made possible the reception of much weaker signals, thus increasing the range of wireless. But, although we honour Fleming as the inventor of the valve, it was another scientist who realised its greatest value to wireless. This was an American, Lee de Forest. In 1906, he added another 'electrode' to Fleming's valve, which he later discovered could be used as a *magnifier* of electric currents.

A powerful microscope can magnify objects several thousand



THE VALVE

A small change of voltage at the grid causes a large change in the current flowing through the valve. Hence, if the small varying currents from an aerial are connected to the grid, they will be reproduced on a much larger scale by the valve current.

The valve thus acts as a *magnifier* of electric currents.

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times. Lee de Forest's 'triode' valve when perfected could be used to magnify tiny electric currents a million times or more. It could not only magnify signals being received, but also those being sent. In 1912, it was found by several experimenters that the valve could also be used in place of the spark transmitter, as a generator of wireless waves. By using several valves to generate and magnify, wireless stations of far greater power could now be built.

Finally, in England and America, wireless engineers had succeeded in using the microphone with the new valve transmitters. In 1907, Lee de Forest himself had experimented with sending a gramophone record 'over the air'. The 'programme' had been received by a wireless operator at a naval yard a few miles away from de Forest's laboratory. It was the first music broadcast in history.

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CHAPTER SIX

A Wonderful Prophecy

WHILST wireless was making great progress, the quest for television continued. About 1908, a Monsieur Armengaud of Paris was reported to have said that he 'firmly believed that within a year, as a consequence of the advance already made by his apparatus, we shall be watching each other over distances hundreds of miles apart'.

The English scientist, Shelford Bidwell, of whose picture telegraph we heard on page 17, wrote a letter to 'Nature' in 1908, commenting on M. Armengaud's claim. He first of all gave a review of the latest developments in sending still pictures by wire. He mentioned the work of other French experimenters, whose apparatus bore such names as 'Téléstereograph', 'Téléautograveur', 'Téléphotographe'. The last, the invention of a M. Berjonneau, had successfully sent a portrait by wire from Paris to Enghien in 247 seconds. But, on the subject of television, Shelford Bidwell was very sceptical. He suggested that the only method feasible was to construct something resembling the structure of the human eye. Every part of the transmitter screen would have to be separately connected by wire with the corresponding part of the receiver screen.

To receive a picture only two inches square, over a distance of one hundred miles, Bidwell made this estimate of what would be needed:—

90,000 each of selenium cells, light controlling devices, and projection lenses for receiver.

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Cable between transmitter and receiver to be 8 to 10 inches in diameter, made up of 90,000 separate wires.

Transmitter screen carrying selenium cells to be 8 feet square.

Lens for projecting image on to the screen to be 4 ft. in diameter.

Receiving apparatus to occupy 4,000 cubic feet.

'The whole thing could probably be done for £1,250,000 but not for much less' Bidwell concluded. 'By an application of the three colour system (as used in printing) it would be possible to present the picture in natural colours . . . The cost would, in that case, be multiplied by three'.

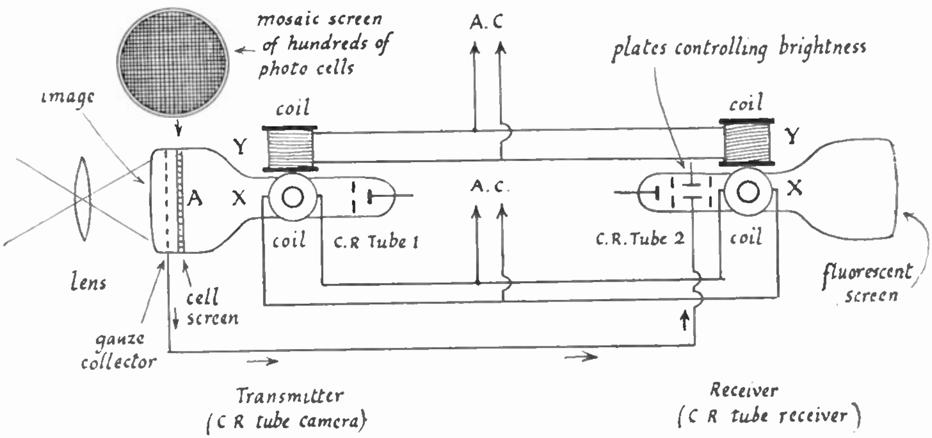
Campbell Swinton

Another English scientist replied to Bidwell's proposals. This was A. A. Campbell Swinton, a well-known electrical engineer, to whom the young Marconi, on arriving in England, had taken his idea of 'telegraphy without wires'. We owe it to Campbell Swinton that he had seen the merit of the young inventor's ideas, and had tried to help him.

Swinton did not believe that Bidwell's system was the only way that television could be achieved. In a letter to 'Nature', in reply to Bidwell, he suggested an entirely different solution to the problem. His system was one which he thought could be used in the future. He was the first to propose a complete television system without scanning wheels or mechanical scanning of any kind. He suggested the use of cathode ray tubes for both transmitter and receiver. In the transmitter, a *cathode ray camera* was to scan the subject to be televised. In the receiver, the picture would appear on a cathode ray tube screen. The receiver was similar to that of Rosing, (page 29) of whose ideas, however, Swinton had not heard.

Swinton knew that no transmitter yet existed which could deal with the rapid changes of light and shade which the scanning camera would record. He calculated that with the large number

World Radio History



CAMPBELL SWINTON'S T.V. SYSTEM

(A simplified version of the diagram he used in explaining his system to the Roentgen Society in 1911).
The receiver was like Rosing's, but the transmitter was Swinton's own idea. Operation was to be as follows:
(1) The image is focussed by the lens, through the gauze on to the photo-cell screen. Each cell becomes charged according to the brightness of its part of the image.
(2) As the beam in C.R. tube 1 scans the screen, it causes each photo-cell in turn to send its current to the gauze. These varying currents travel along the wire to control the brightness of C.R. tube 2.
(3) The deflection coils of both tubes are connected to the same electric generators, which supply alternating current (A.C.). This means current which is continually reversing voltage. Hence the beams are deflected, and their scanning kept in step.

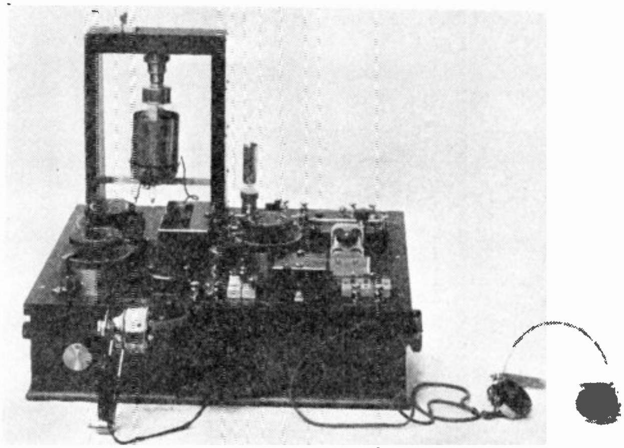
of scanning lines needed for 'high definition' (see page 4) over 160,000 changes of light would have to be transmitted *each second.*

Two or three years later Swinton presented his ideas worked out in greater detail to a scientific society. They appear to us astonishingly correct. He had made a wonderful prophecy. Thirty years later his system became the basis of modern television.

In 1908, the year of Swinton's prophecy, the transmitter he was looking for was already on its way. On the other side of the Atlantic, de Forest was working on his triode valve. As we saw in the last chapter, the first wireless transmission of *sound* had already taken place.

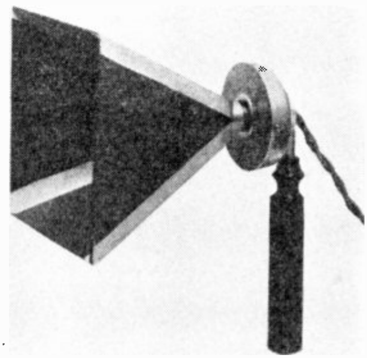
Unfortunately the First World War broke out in 1914, bringing

World Radio History



Sounds by wireless: one of the first wireless telephony sets, a combined transmitter and receiver. Note the microphone and headphones.

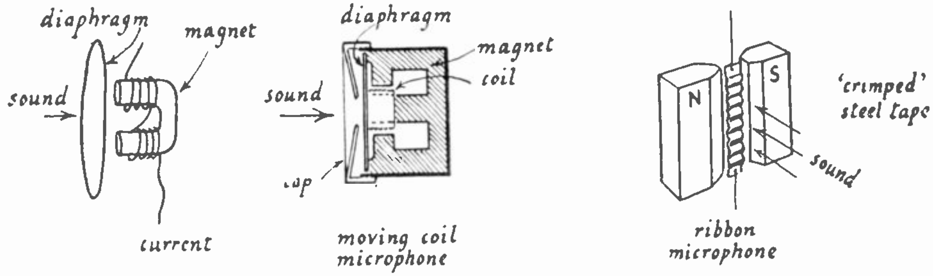
most of the experiments in television to an end for several years. It is quite possible that had the war not taken place, we should have had a working television system by the early 1920s. Wireless, however, continued to develop during the war as a means of communication. The navies and ships of both sides used it extensively for sending signals. Because anyone could receive these signals, secret codes were used. Merchant ships radioed for help when attacked. Coastal stations maintained watch and reported the movements of enemy ships.



The beginnings of broadcasting: the crude microphone with a trumpet made from a cigar box which was used by the famous singer Melba in a broadcast from Chelmsford in 1920

In the field, armies used wireless very little at first because of its lack of secrecy, and relied chiefly on wired telephones to keep

World Radio History



THE MICROPHONE

Sound makes the thin steel disc (diaphragm) move rapidly to and fro (vibrate). An electric current is caused in the coils of the electro-magnet. The microphone is therefore a *generator* of electric currents which vary with the sound. There are other kinds of microphones but *all* cause varying electric currents.

front line and headquarters in touch. There was little reason to change the arrangement. Both armies remained entrenched for the greater part of the war, in a state of almost deadlock. With the introduction of the tank by the British, however, the need arose for a 'short range' wireless which these vehicles could carry.

Wireless Progress

When the war ended, wireless rapidly advanced as a means of international communication. By 1921, regular long-distance services were being planned across the world. Within a few years, telephone messages could be sent by wireless. Although the cost was great, it became possible to 'ring up' another person thousands of miles away.

Broadcasting, also, was now on its way. In 1921, gramophone records played before a microphone in Chelmsford, England, were heard through a loud-speaker by passengers on a ship in mid-Atlantic. Regular broadcasting services began in the next few years and by the first quarter of the twentieth century, not only could 'Nation speak to Nation' but entertainment, music, talks and plays could be sent out and received in people's homes.

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CHAPTER SEVEN

Pictures by Wireless

THE exciting developments in wireless just described also meant new hopes for television. More powerful transmitters and more sensitive receivers became available for experiments.

In 1923, an experimenter in Hastings, England, sent a 'picture' of a cardboard cross through a wire for a distance of two feet, in his bedroom. His name was J. L. Baird. The same year, an American in Washington sent a silhouette picture by wireless. The American was C. F. Jenkins, who used Nipkow discs for his transmitter and receiver. The picture was a profile of the President of the United States at the time, President Harding. It was sent from Washington to a newspaper office in Philadelphia, a distance of 130 miles.

'*Facsimile*'

In London, at the same time, another method of sending still pictures by wireless was coming into being. Richard Ranger had developed a way of sending pictures in full detail. This method is called facsimile. A similar method is used widely nowadays by newspapers wishing to print photographs of events taking place thousands of miles away. For example, the pictures of Fuchs and Hillary at the South Pole were received in London and New York on the same day or the day after they were taken. They were thus able to appear in the papers along with the news of the expedition. Such pictures are scanned and sent line by line 'through the ether'.

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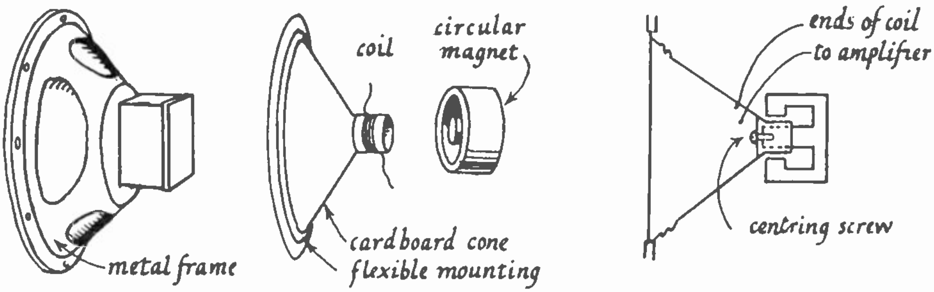

THE LOUDSPEAKER

The loudspeaker works like the microphone in reverse. Currents from the T.V., radio receiver, or gramophone cause magnetism in the coil. This causes the coil to be attracted to or repelled by the permanent magnet. As the current varies, this causes corresponding movements of the cone, thereby causing sound.

They are received by a machine which prints each line as it is received, until the complete picture is built up.

In 1924, Ranger sent by his process, photographs of President Coolidge, the Prince of Wales, and the British Prime Minister, Stanley Baldwin. The photographs were sent from London to New York. The time taken to transmit them all was twenty minutes. The next year, Ranger beat this record by sending photographs and maps for a distance of 5,000 miles, from New York to Honolulu. In 1926, to demonstrate how perfect his process had become, he sent a picture of a cheque from London to New York. The reproduction was so good that the cheque received was accepted and cashed by the New York Bank, to whom Ranger sent it.

The sending of still pictures by wireless was thus an accomplished fact in 1925, fifty years after Senlacq. Baird and Jenkins were sending silhouettes which could be seen by a 'viewer' at the receiving end. Ranger was sending photographs and drawings which were reproduced by a printing device controlled by the receiver.

Neither of these processes was yet 'Television' in our sense.

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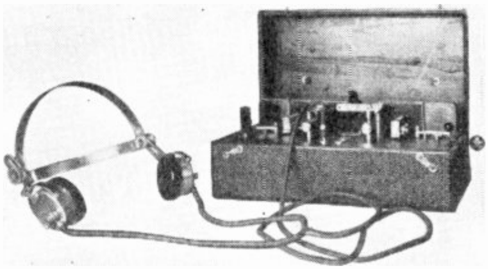
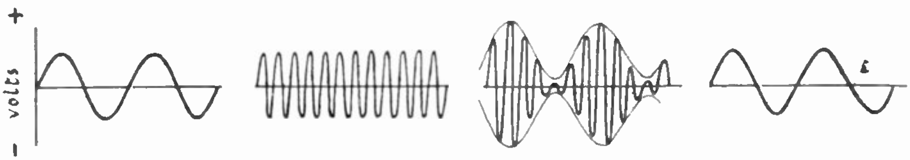


A domestic crystal wireless receiver used for listening to the B.B.C. in 1923

A two-valve domestic wireless receiver used with headphones in 1923

Broadcasting

On New Year's Eve 1923, engineers of the recently formed B.B.C. fixed microphones to pick up the chimes of Big Ben as he struck the last twelve o'clock of the old year. This was the first Big Ben broadcast. By the end of the next year, 1924, there were over 600,000 listeners. They 'listened in' to the programmes through earphones attached to home-made crystal or battery-



INFORMATION BY RADIO

1. The microphone current rises and falls with the sound waves.
2. Shows the radio 'carrier wave' with the microphone 'dead'.
3. The carrier wave rising and falling as it is 'modulated' by the microphone current.
4. Demodulation is the process of passing the *rise and fall* of the carrier to the amplifying valves. The result is a copy in the receiver of the original microphone current.

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Studio No. 1, at Savoy Hill, the B.B.C. headquarters in 1923

driven sets. Loudspeakers followed a little later, at first simply horns or trumpets attached to large telephone earpieces.

The coming of broadcasting proved to be the greatest advance in spreading news, information, and education since the invention of printing.

In the United States, broadcasting began in 1920. The American system was and still is, 'commercial radio'. In this system, the programmes are paid for by advertisers, not the listeners. In Britain, the B.B.C. became a state institution, paid for by money from listeners' licences. As broadcasting spread through the world, the various countries adopted whichever of these two systems seemed to suit them best.

Meantime C. F. Jenkins in Washington had been making progress and in 1925 had succeeded in sending images of *moving* silhouettes. Then, in England on January 27th 1926, John Logie Baird gave the world its first demonstration of practical television.

John Logie Baird

Baird was born in 1888 in Helensburgh, near Glasgow, where

World Radio History

his father was the Minister of the West Parish Church. From early childhood his health was poor, and remained so throughout his life. After some years at a preparatory school, his parents sent him to a private school called 'Larchfield'. His schooldays do not appear to have been very happy. Because of his liability to chills and colds, the school's emphasis on games seems to have been a great trial to him. He tells us that his education included no form of science, and very little mathematics. Latin, which he hated, was his worst subject. Year after year he was kept down in the same class because of this.

We get some idea of the future Baird, however, by his spare time interests. One of these was photography. A craze for cameras spread among the boys at the school at this time. Baird saved every penny of his pocket money to buy a camera for himself. It was a 'dream camera', he tells us, the envy of his friends. It seems to have been a very complicated affair, and because of owning it, he became the chairman of the school Photographic Society. The Society's meetings were taken up with learned discussions on darkrooms and developing and other technicalities. Exhibitions were arranged of the efforts in photography of the enthusiastic members.

Another subject which caught his imagination and that of many of his friends was flight. This was no doubt due to the sensational exploits of the Wright brothers whose first flight had just taken place. He and a friend read everything they could about the new science and decided to build a flying machine of their own. At first it was to be a glider. Later, an engine was to be added.

Construction took a fortnight. For the first trial the kite-like contraption was hauled up on to the roof of a school building, unobserved by any adult who might interfere. Baird's friend was to be the daring aeronaut who first tested the machine, but somehow the two changed places. The end of the experiment is best told in Baird's own words.

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THE RADIO TIMES

THE OFFICIAL ORGAN OF THE B.B.C.

Vol. 1. No. 1. EVERY FRIDAY. Two Pence.

OFFICIAL PROGRAMMES OF THE BRITISH BROADCASTING COMPANY.

For the Week Commencing SUNDAY SEPTEMBER 30th.

SPECIAL CONTENTS:

LORD GAINFORD'S MESSAGE TO LISTENERS

P. P. ECKERSLEY ON SIMULTANEOUS BROADCASTING.

A SONG OF ANCIENT CHINA.

GOSSIP ABOUT ARTISTES.

WIRELESS HUMOUR.

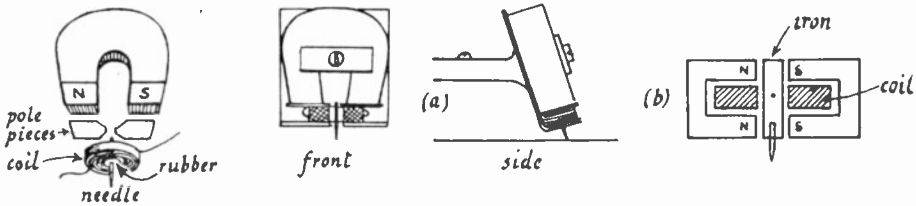
THE "UNCLES'" CORNER.

LETTERS FROM LISTENERS

WHAT'S IN THE AIR?

By ARTHUR R. BURROWS, Director of Programmes.

The 'Radio Times' which started publication on September 28, 1923



(a) simple magnetic gramophone pick-up (b) balanced armature type

The gramophone pick-up is a small electric generator. The steel needle, moving backwards and forwards as it follows the wavy sound track, generates a current in the coil. To make records, the process is reversed. Current from a microphone passing through the coil causes the needle to cut a wavy track on a blank record.

'Before I had time to give more than one shriek of alarm, Godfrey gave the machine one terrific push, and I was launched, shouting, into the air. I had a few very nauseating seconds while the machine rocked wildly and then broke in half, and deposited me with a terrific bump on the lawn'.

Because of his keenness for scientific and technical matters, Baird went on from school to the Royal Technical College, Glasgow. There he gained the college Diploma in engineering which carried with it an entrance to Glasgow University. In 1912 he had taken his B.Sc. degree and obtained his first post with an electricity supply company.

His ill-health, which had continued during his college career, proved to be a handicap for the rest of his life. Because of it he was obliged to give up engineering as a career. For a number of years he was engaged in various business ventures. When illness had caused him to give them up, one after another, he decided to go abroad. The place he chose was the West Indies, where he imagined the climate might suit him better.

Unhappily, his attempts to earn a living there proved no more successful, and he was compelled to return to London with almost all his money gone. His final attempt to earn a living was in selling soap, but before long he was ill again. His doctor advised

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John Logie Baird

him to leave London, and suggested a stay by the seaside to restore his health.

In 1923, he arrived in Hastings, 'coughing and choking and so thin as to be almost transparent'. He now had about £200 left from his various business deals. Whilst the sun and sea air were repairing his health, the problem of earning his living remained. His chances of a job were small. His spirits were not damped however, in spite of everything. When he had considered his prospects, he decided that one thing only remained. 'I must invent something', he thought.

Then one day, during a walk over the cliffs, he thought of his earlier interests in electricity and engineering. It was now that he remembered the subject of 'seeing by electricity' which had interested him many years before, probably when he was a student. Back in his lodgings, he decided to try over again some experiments he had carried out at that time. Since then there had been great progress made by wireless, and the invention of the valve amplifier. So, in his bedroom, he began to build a model.

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CHAPTER EIGHT

Real Television

BAIRD bought valves and batteries, a tea-chest, a bulls-eye lens, darning needles, glue and sealing wax. A large hat box provided the cardboard for the Nipkow disc. Holes were pierced in the disc, and one of the darning needles was used for a spindle. An electric fan motor drove the model. On one side an electric lamp shone on a little cross which cast its shadow on the disc. Behind the disc Baird placed a photo-electric cell, so that the intercepted light from the lamp fell on it. So far this model was similar to the Nipkow disc apparatus on page 21. Baird, however, connected the photo-electric cell to a valve amplifier, and thence to the lamp of his receiver. The diagram opposite shows the arrangement. Notice that, for the purposes of the experiment, Baird used the same scanning disc for both sending and receiving. The receiver used the opposite edge of the disc to the sending part. The scanned image of the little cross was thus sent via the photo-electric cell and the valve amplifier to the lamp of the receiver. This lamp glowed only when the photo-electric cell was receiving light from the disc. As a result, when the disc revolved, one could see the shadow of the little cross, which had been thus 'televised' along the diameter a distance of about two feet.

'*Seeing by Wireless*'

Baird was elated by his success. He became convinced that with better apparatus he could devise a working television system.

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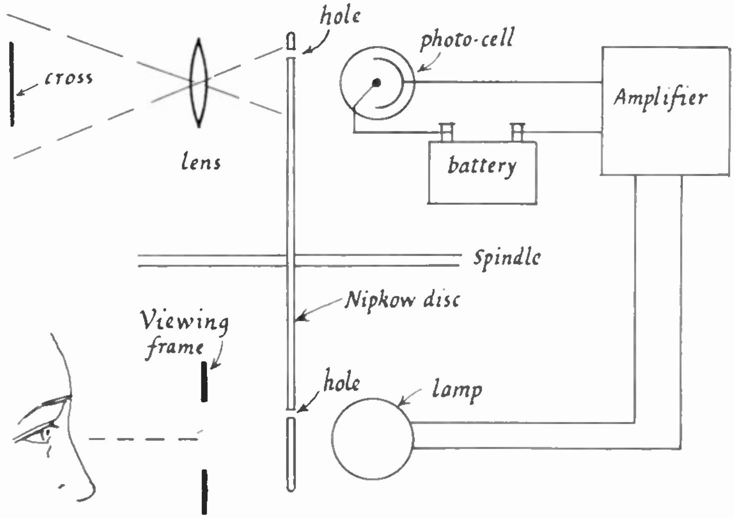

BAIRD'S FIRST MODEL
A diagram showing the arrangement using a single disc for transmission and reception.

To build a better model however, he needed money. To get that, he decided to give a demonstration of his existing model to the press. The outcome of this piece of over-optimism was a very small paragraph in the 'Daily News'. His father was shown the paragraph by a friend, and sent Baird £50 as an encouragement.

Our inventor now hired a small room above a shop for a laboratory, at a rent of 5s. 0d. a week. Here there was more room than in the bedroom in his lodgings. Gradually the model grew and the results improved. Assistance was soon required for more ambitious experiments. Baird decided to advertise. The following then appeared in the 'Personal' column of 'The Times' 27th June 1923.

> 'Seeing by Wireless—Inventor of apparatus wishes to hear from someone who will assist (not financially) in making models.
> Write Box . . . The Times E.C.4'.

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As a result of this advertisement, Baird received help and friendly advice from a number of people, one of whom was A. G. D. West, Assistant Chief Engineer of the B.B.C. The engineer discussed Baird's ideas with him, and some of the difficulties of broadcasting light instead of sound waves. After helping him by supplying him with valves, transformers and other wireless apparatus, West went to Hastings to see the model. The impression he gained, we are told, was that Baird's ideas were good, but that it would be a considerable time before they were practicable.

Later on, Baird was turned out of his laboratory over the shop in Hastings by the landlord, who was afraid of damage being done to his property. The model was transported as a result to London to an attic at 23 Frith Street, Soho, where Baird now continued his work.

Then came a change of luck. Gordon Selfridge, Junior, was looking, at the time, for ideas for the Birthday Week Celebrations at his store in Oxford Street. He had heard about Baird's model, and thought it would be an attraction. He offered Baird £20 a week for three weeks to give three shows a day to shoppers. Baird accepted.

The model was fitted up in Selfridges and the demonstrations of television which followed were the first to be given to the public anywhere in the world. Shoppers were shown the televising of a paper mask. Part of this apparatus is now in the Science Museum, South Kensington, and is illustrated on page 53. The photograph shows the ventriloquist's dummy which was used later on. The demonstration brought some other good fortune besides the £20 per week. Two firms, Hart Accumulators and the General Electric Co. Ltd. had witnessed the demonstrations. They now kindly helped with batteries and valves—to the value of £200 in each case—to encourage Baird's pioneer work. Then Baird's Scottish relatives helped him with £500, and for the first time it seemed as though he had a real chance to develop the invention.

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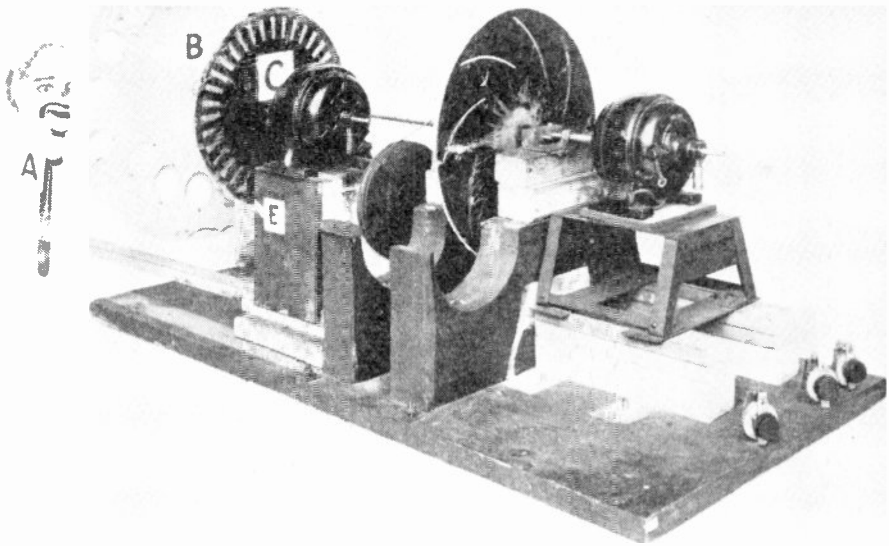

Baird's apparatus now in the Science Museum, South Kensington. With this he gave his first public television demonstration.

Light and Shade

It was important now to improve the quality of the television 'picture' being received. Up to this time the flickering images seen by people looking in to Baird's apparatus were little more than vague shadowy shapes. Baird now worked upon improving the model, until quite unexpectedly final success came. He was now using the ventriloquist's doll and he tells us how on a Friday in October 1925, the dummy's head 'suddenly showed up on the screen, not as a mere smudge of black and white, but as a real image with details and with graduations of light and shade'.

He tells us next how in great excitement he tried to transmit a living person.

'The first person to appear was the office boy from the floor

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below, a youth named William Taynton . . . I placed him before the transmitter and went into the next room to see what the screen would show. The screen was entirely blank . . . The boy, scared by the intense white light, had backed away from the transmitter. In the excitement of the moment I gave him half a crown, and this time he kept his head in the right position. Going into the next room, I saw his head on the screen quite clearly.'

The First Demonstration

Baird now wanted to let the world know about his achievement. Accordingly, he invited members of the Royal Institution and 'The Times' newspaper to a demonstration. So, on the evening of Friday, 27th January 1926, more than forty distinguished people arrived in evening dress at Frith Street.

The demonstration was a success, although one old gentleman is said to have got his beard caught in the spinning disc. The visitors were invited to squeeze into the tiny laboratory, six at a time. Some permitted themselves to be televised and their features were seen by their friends in the adjoining room. The next day, the visit was described in 'The Times'

'. . . on a receiver in the same room as the transmitter, and then on a portable receiver in another room, the visitors were shown recognisable replicas of the movements of the dummy head and of a person speaking. The image, as transmitted, was faint and often blurred, but substantiated a claim that through the 'televisor', as Mr. Baird has named his apparatus, it is possible to transmit and reproduce instantly the details of movement, and such things as the play of expression on the face . . .'

Then reporters from the other papers began to call and Baird had visits from scientists, engineers, and others who were interested.

Baird now tried to show that television over greater distances was possible. He therefore got into touch with the Chief Engineer of the B.B.C., who at once promised to help. Several transmissions

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were arranged. Baird sent his television 'picture' by telephone line from Frith St. to a B.B.C. studio. From thence it was broadcast by the London wireless station. Baird received the 'picture' by wireless back in his laboratory, and reconstructed it with his television receiver. This was in 1926. Baird tells us that 'the picture came through the B.B.C. practically unaltered'.

Encouraged by this result, he applied for a licence to run an amateur television station. This was granted by the Post Office, and the station was known as 2TV. A company was now formed called Television Limited with Baird and two of his backers as directors. Premises were acquired at Motograph House, near Leicester Square. Here for the first time, Baird had a real laboratory to work in, and a capable assistant, B. Clapp, who had considerable experience in long distance wireless transmission. A receiving station was arranged at a house in Harrow, and wireless masts were erected over Motograph House for the transmitter.

News of Baird's achievements had by now been received in every country in the world. Other experimenters worked hard to perfect their methods. Britain, for the time being, was in the lead, and Baird did his best to maintain the lead.

In April 1927, the American Telegraph and Telephone Company went into action with tremendous press publicity. 'Television at Last' they called their demonstration. Pictures were sent over 200 miles by telephone wire between Washington and New York. Finally, pictures were sent by *wireless* over a distance of thirty-two miles.

Baird's reply was to outdo this American demonstration by one of his own. That May, he sent pictures over 400 miles by telephone wire, between London and Glasgow.

Across the Atlantic

The following September, a more ambitious plan occurred to him, one which should establish beyond doubt the fact that he had

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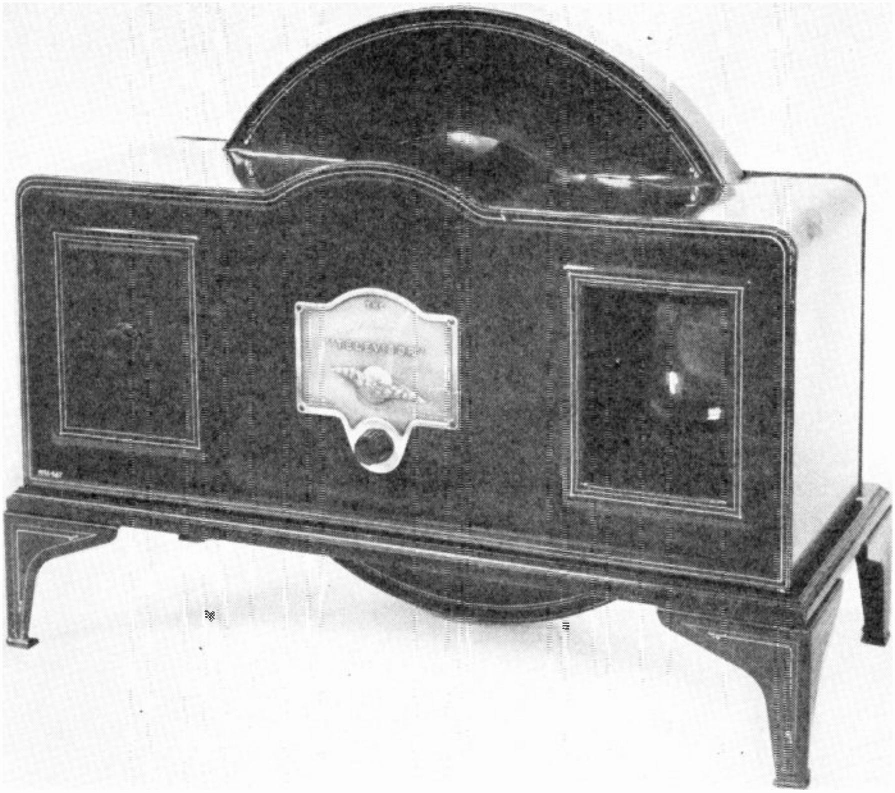

A Baird 'Televisor'

made television a reality. He sent his assistant, Clapp, over to New York to try to receive a television transmission from London. After some months of experimenting, the first test of television across the Atlantic was announced.

On February 8th 1928, newspaper men and other guests gathered in Baird's new Long Acre Studio at midnight. A doll was televised first. The image was sent by telephone wire to the Baird Company's experimental wireless station at Couldson, Surrey, and was broadcast on 45 metres.

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In New York, it was 7 p.m. by American time. The short wave transmission from England was picked up by an American amateur, in a New York suburb. The signal received was then used to operate a Baird receiving 'televisor' with a tiny glass screen measuring only two inches by three inches. Four people in New York sat watching this screen. They were B. Clapp and Capt. O. G. Hutchinson of the Baird Company, a representative of Reuter's Press Agency, and the American radio amateur, whose name was Hart.

When the doll's head had been properly tuned in, Hart used his transmitter to inform London. Now Baird replaced the doll and sat himself before the televisor in Long Acre. For half an hour he sat there moving his head about until New York came through again saying that he had been seen clearly.

This was a great achievement. The 'New York Times' commented:

". . . all the more remarkable is Baird's achievement because he matches his inventive wits against the pooled ability and vast resources of the great corporation physicists and engineers, thus far with dramatic success'.

Clapp returned to England in the *Berengaria* a week or so later. Whilst in mid-Atlantic he received a picture on a television receiver installed in the liner. Like the New York demonstration the picture was small and crude. It made a great impression, however, on those privileged to be 'viewers'.

In June, Baird successfully televised objects out of doors, using the daylight for illumination. Not content with this, he now tried television in colour! It is a surprising fact that television in colour began in 1928. Baird demonstrated his system in London and Glasgow. At the same time, a similar method was being shown in the Bell Telephone Laboratories in America. You can read how these systems worked in the section on colour television in the last chapter of this book.

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CHAPTER NINE

The First Television Broadcasts

BAIRD had begun his work on practical television whilst broadcasting itself had only just started developing. In the U.S.A., hundreds of local radio stations had sprung up, creating chaos on the air. The Government was forced to intervene to control the number of stations and the wavelengths they could use. One result was the formation of the two large American 'networks', the National Broadcasting Company in 1926, and the Columbia Broadcasting system in 1927.

Meantime, that other great means of entertainment, the cinema, introduced something new and exciting to its audiences. On August 7 1926, Warner Brothers gave the first demonstration of the 'Vitaphone'. Talking pictures had arrived. From that time onwards the silent film began to be replaced by the sound film we know today.

American experiments in television continued. In September 1928, the General Electric Company broadcast a television drama called 'The Queen's Messenger'. Three cameras were used, each covering a very small area of the scene being televised. One camera was focused on each of the actors. The remaining camera was used for 'props' and actors' hands. The cameras were faded in and out at the producer's direction.

Television now also began in Germany. In 1929, the Reichpost started experimental transmissions using Baird's methods, by arrangement with the Baird Company.

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The B.B.C. Assists

Then, at the end of September 1929, came the most important news of television so far. The B.B.C., in co-operation with Baird's Company, started an experimental television service.

Up to this time, perhaps naturally, the B.B.C. had not been convinced that television was advanced enough to have any entertainment value. The Postmaster General, who at that time, directly controlled the B.B.C. wrote to the Baird Company on May 27th 1928. This letter showed that the B.B.C. would now be prepared to help with experiments. The P.M.G's. letter put the Government's view as follows:

'The Postmaster General . . . does not consider that at the present stage of development, television could be included in the broadcasting programmes within the broadcasting hours. He bases this view not so much on the quality of the reproduction, which further experiments may be expected to improve, as upon the present limited scope of the objects which can be reproduced'.

The letter then went on to outline the help which would be given by the B.B.C. for experimental transmissions outside regular broadcasting hours. This help proved to be the turning point in Baird's fortunes, and provided the beginnings of the first regular T.V. service in the world.

The first of these television broadcasts was on September 30th 1929. Baird himself estimated that it could have been received by only thirty people at the most, for that was the total number of receivers in existence at the time. He told newspaper men, however, that there would soon be large numbers of sets available when the Baird Television Company had had time to organise their manufacture. 'Amateur Wireless', a popular wireless magazine, gave its readers this description of the type of receiver in use at the time.

'One sees the image through a wide lens about eight inches in diameter, and the general effect is similar to looking into an automatic picture machine as installed in amusement halls. The

E

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image appears as a soft-toned photograph, illuminated by a reddish orange light'.

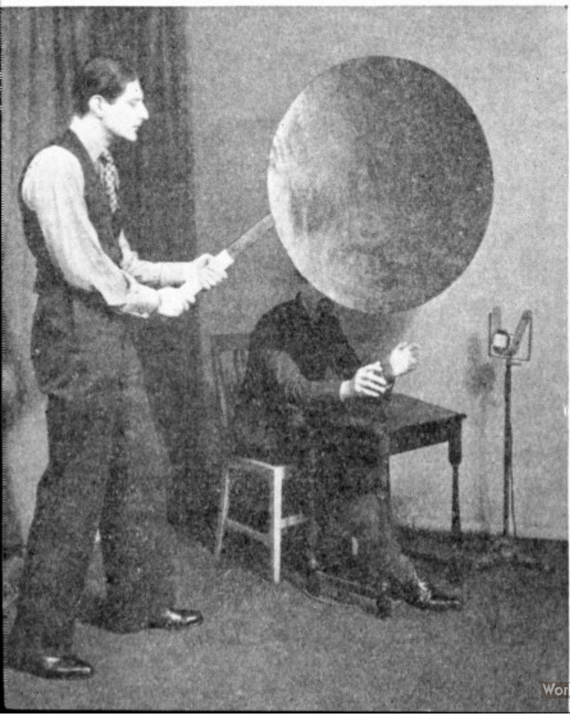
The first 'programme' consisted of speeches by two distinguished scientists, Sir Ambrose Fleming (inventor of the wireless valve) and Professor E. N. da C. Andrade. Light entertainment followed, given by three artists.

The London station 2LO had only one wavelength on which to broadcast sound and vision. The difficulty was overcome by making each person do his broadcast act *twice*. First, the speech was broadcast, then the performance was repeated for the vision broadcast. 'Viewers' heard the speech, then saw the broadcaster making the lip movements of the sounds they had just heard!

The London 'Evening News' gives us another description of television reception on this occasion, describing the broadcast as seen on a 'Baird Televisor':

'Four or five people simultaneously can see the image in a television receiver, where it appears in a round glass lens about the size of a saucer'.

The difficulty of sending out vision and sound together from a wireless station is that *two* transmitters are required, each on a different wavelength. By 1930, the B.B.C. had a new station for the London Region at Brookman's Park, with transmitters able to radiate on 356 and 261 metres. In March of that year, the experimental television broadcasts were able to continue with sound and vision sent out simultaneously.



'The Man with a Flower in his Mouth', the first television play broadcast by the B.B.C. in 1930. The circular board was used to 'fade out' scenes.

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The First Play

The first televising of a play by the B.B.C. and Baird's organisation followed on July 14th. It was 'The Man with a Flower in his Mouth' by Pirandello. The actors were Val and John (later Sir John) Gielgud. The play was acted in the Baird Company's Long Acre studio, which was connected by wire to the B.B.C. control room at Savoy Hill.

By now, television receivers similar to that on page 56 were being sold at twenty-five guineas each, and the number of 'viewers' slowly grew.

The 'Big Screen'

Experiments in television were now also being carried out on the Continent and in America. One of the things receiving attention was the size of the receiver screen. As we have seen, viewers up to now saw their television on a screen about the size of a saucer. In April 1930, Americans saw a demonstration, given by an engineer named U. A. Sanabria, of a television screen two feet square. A month later E. F. W. Alexanderson, who had been in charge of the G.E.C. broadcast of 'The Queen's Messenger', gave a 'big screen' display in a theatre in Schenectady. This screen measured six feet by seven feet, and the audience saw on it a vaudeville show.

In England, Baird showed that he was by no means behind in the 'big screen' contest. His American rivals were using a 'light valve' by which a projection lamp could throw the T.V. picture on to a screen. This was an important advance, although the large pictures were rather dim by our standards. Baird used this method himself later on to improve his receivers, but for *his* 'big screen', he devised something entirely different.

He arranged 2,100 very small electric light bulbs on a board behind a sheet of frosted glass about five feet by two feet in size. Each light bulb was connected to a contact on a huge rotating electric switch. This switched on each lamp in turn, beginning at

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the top row. In order that the eye should be able to 'remember' the first lamp when the last lamp was glowing, the switch had to have switched on *all* the lamps in one twelfth of a second!

By permission of Sir Oswald Stoll, Baird erected his 'big screen' in July 1930 on the stage of the Coliseum Theatre, London. When the lights went down for the television stage show, the theatre was plunged into complete darkness. Then the screen, which was on the stage, surrounded by black curtains, lit up. It is difficult for us to imagine the effect on that large audience, which had never seen television before, when the announcer's face appeared on the screen, and he began to talk. There was tremendous enthusiasm. The audience were allowed to ask questions of the television speaker. Their questions were telephoned from the theatre to the Baird Long Acre studio, and the image on the screen replied. We are told that the television picture was remarkably bright, and that the screen rendered all the shades of light and dark of the speaker's face.

The Derby, 1931

During 1930, Baird had been experimenting with televising scenes outside the studio. In May 1931, he had a van equipped with cameras and apparatus and successfully used it to televise objects out of doors. This led him to make a promise which seemed rash, even to his friends. He announced that he would televise the famous horse race, the Derby.

On the day of the race, Baird's 'mobile van' equipped with what now seems very primitive apparatus, went down to Epsom. It took up its position opposite the winning post. The van was connected via the ordinary telephone wires to the Long Acre studio, and from thence to the B.B.C.

There were all kinds of technical difficulties and troubles. Baird's staff had the most anxious moments putting matters right in the nick of time, before the race began. The people looking into

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their television sets began to see blurred shots of the scene on the racecourse, of the crowds, the bookmakers, and the horses and jockeys coming out for the start. All this was also being described by the B.B.C. commentator on sound radio, but never before had these things been seen as well as being heard over the air.

The pictures were crude, flickering, blurred and distorted at times, and never clear in detail. The race started, the commentator described the rounding of Tattenham Corner, and a few moments later viewers saw the exciting finish as the horses flashed by the post. It is doubtful whether viewers were able to actually recognise the winning horses, but what they had seen and heard was an unforgettable experience.

It was Baird's greatest triumph so far, surpassing in the public imagination even his trans-Atlantic test. Credit must also be given to Baird's capable staff, including W. W. Jacomb, his chief engineer, J. D. Percy, T. H. Bridgewater and D. R. Campbell. The two latter were later to occupy leading positions on the B.B.C. television staff.

Baird's relations with the B.B.C. now began to improve. One can understand why the B.B.C., in control of a new public service only four years old, should be cautious in their attitude to television. There is no doubt that the Corporation wanted Britain to be the first country in the world to launch a public television service. They had to be convinced that television had reached the stage when it could really provide entertainment. They were also aware that systems other than Baird's were being tried out. Baird himself was not an easy person to deal with, and appeared even to his friends to be over-optimistic about his inventions. At this time he was very impatient to get his system adopted without further delay.

After the Derby broadcast, the B.B.C. offered Baird the use from time to time of one of their studios. They also began discussions with the Baird Company on the subject of the B.B.C. taking part in the actual television programmes and in television

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research. These discussions lasted several months. In the meantime, Baird Television Ltd. broadcast its programmes early in the day, and, at certain times after normal broadcasting had ended, the B.B.C. put on its own programmes using Baird apparatus.

A great problem facing the B.B.C. was that there was no wireless station to spare on either long or short waves which could be used for full-time television. Neither could one be built, because by this time, Britain had her full share of the wavelengths allotted to her by international agreement. In addition, for technical reasons, ordinary sound broadcasting wavelengths were not really suitable for television, particularly if pictures giving more detail were to be transmitted. Further, *two* wavelengths were required by a television station: one for vision, the other for sound.

There was a way out of this difficulty, and that was to use short waves. Baird himself now began to experiment with short wave transmissions. In America, such experiments had already been taking place.

In 1932, Baird repeated his outside broadcast of the Derby, this time even more successfully. By now, 10,000 'Televisors' had been sold. Their owners had a close, but still hazy view of the finish. Baird also had erected a 'big screen', this time measuring eight feet by ten feet, at the Metropole Cinema in London and the audience were able to see the exciting finish of the race.

This fact caused an even bigger sensation than the broadcast of the previous year. Many more people were now convinced that television had arrived.

The difficulties of providing a regular service still remained however, and as yet the pictures, by our standards, were still very crude.

As a result of Baird's work, other organisations in England had begun to take a more serious interest in television. One of these was the pioneer wireless company, Marconi's Wireless Telegraph Co. Ltd. For some time they had been working on the problems of

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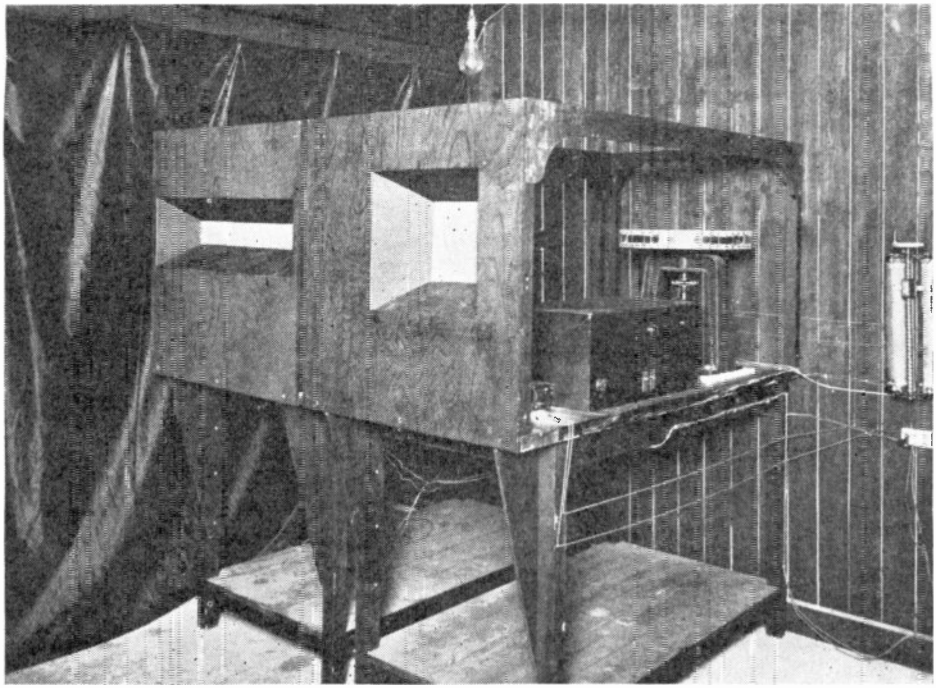

The Marconi television demonstration at York, 1932. *The receivers were for an eight inches square head-and-shoulders picture, and for a twenty-five by three inches news message.*

designing wireless transmitters and aerials specially for television. They now set up a television research group under the direction of R. J. Kemp.

At first, this group investigated the possibilities of using television for purposes other than entertainment. For example, it was thought that for public meetings and other events, the head and shoulders of a speaker might be displayed on a large screen as he spoke. Another idea was that news messages might be shown on a screen in the form of words passing across it in succession. Demonstrations of both these ideas were given in July 1932, when pictures were sent from Chelmsford to Australia by short wave

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wireless. The messages were typed on a tape which was then passed through the scanner. In Australia, they were seen on a small screen, the words passing across it at the rate of about 60 five-letter words a minute. In August of that year, a similar demonstration was given to the British Association at York, this time using medium-wave wireless.

In September 1933, the British Association was given a further demonstration at Leicester. This time the picture was projected on to a screen five feet square, and seen by a large audience.

Another company which became interested in television was the Gramophone Company Ltd. of Hayes Middlesex (better known by their famous trademark 'His Master's Voice'). In 1930, they formed a team, led by G. E. Condliffe and C. D. Browne, which began to study methods of obtaining *higher definition* (see page 4) than that being used by Baird. In January 1931, they gave a demonstration at the Imperial College, London, using mirror-drum scanning. The screen measured 2ft. by 2ft. 6ins., and the definition was 150 lines.

Later on that year, the Gramophone Company combined with other companies to form Electrical and Musical Industries Ltd. (E.M.I.). A Director of Research was appointed, whose name was Isaac Schoenberg. Very important work now began on a new kind of television receiver, based on Boris Rosing's idea of using a cathode ray tube.

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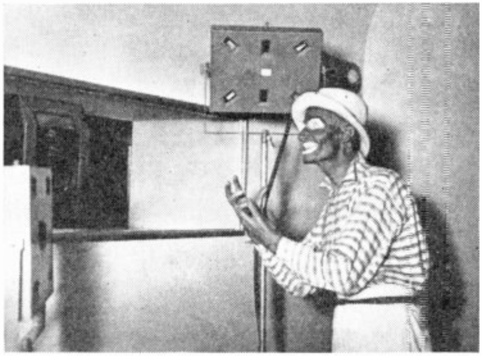
CHAPTER TEN

The B.B.C. takes over

THE discussions between the B.B.C. and the Baird Company at last came to an end in 1932. The B.B.C. had decided that it would now run experimental television programmes itself, and also organise research into television methods. A new post was created in the B.B.C., that of Television Research Engineer. Douglas Birkinshaw, a science graduate from Cambridge University, was appointed. He was given the task of recruiting staff, conducting laboratory research and running the experimental transmissions. A television transmitter was ordered from the Baird Company. One of the B.B.C.'s fine studios, Studio BB, was handed over to television and equipped for its new job. Two of Baird's best men, D. R. Campbell and T. H. Bridgewater were transferred to the B.B.C. staff by agreement between the two organisations.



Fred Douglas about to give a performance before the camera in Studio BB

The first B.B.C. Director of Television Programmes was Eustace Robb, who made a wonderful beginning. From August 1932, for the next one and a half years, world famous stars of theatre, ballet, and variety, as well as polit-

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Studio BB at 16 *Portland Place, used by the B.B.C. for television in* 1932

icians and other well-known personalities came before the cameras. Transmissions were on four evenings per week, from 11 until 11.30 p.m. Vision was broadcast on 261 metres, sound on 356 metres.

Low Definition

The efforts made to organise these programmes were all the more remarkable when we consider the kind of picture which was received. Viewers, using their televisors, looked into a narrow slot-like opening 9 inches wide by 4 inches deep. The pictures were grey and indistinct, and the 'lines' were much in evidence. The definition was only 30 lines per picture. (See page 4).

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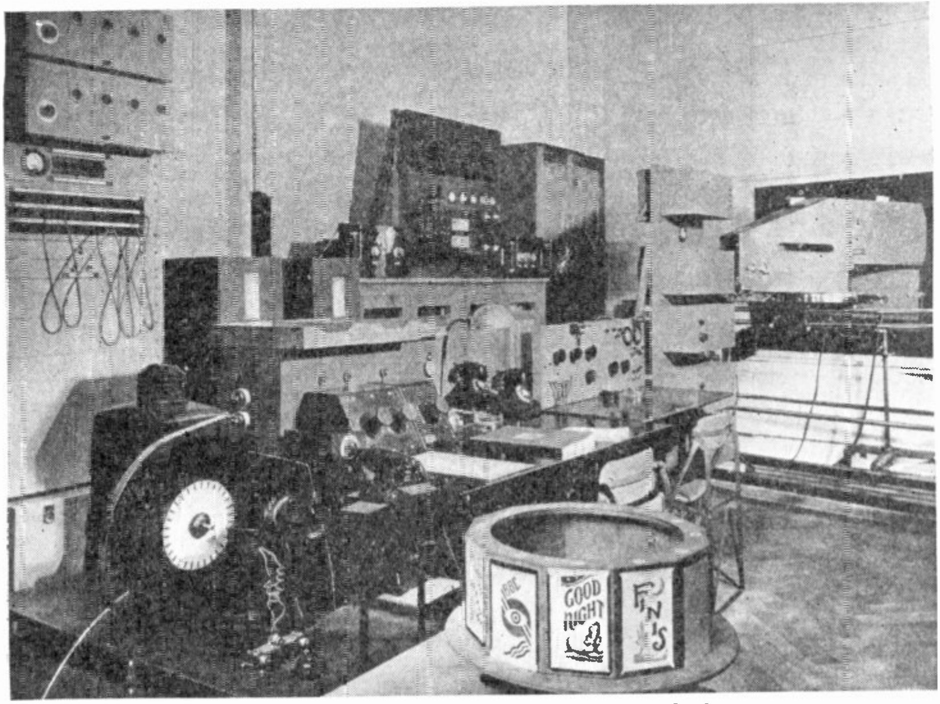

The television control room at 16 *Portland Place*

Because of the lack of detail in the pictures received, people being televised, including even the most important people, had to be given a very heavy make-up. There was great variety in the programmes. Almost every kind of experiment and 'surprise' was tried. Close-ups were the only kind of shot really practicable. A play entitled 'Posters', specially written for T.V. was produced. The first television review, called 'Looking-in' took place. This revue even had a line of chorus girls, who, however, could only vaguely be seen.

In America, and other countries, television broadcasting had also begun to develop. There were at least fifteen television companies at work in the U.S.A. in 1931. The Columbia Broad-

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casting System opened its experimental station in July 1931, and began a series of quite ambitious programmes. The Radio Corporation of America placed its station at the top of the Empire State Building in New York. The American engineer, Ulysses A. Sanabria, showed pictures on a still larger 'big screen'. This time, the screen measured ten feet high, and was shown at the Radio Electrical World's Fair in New York. Television also began in Italy and Austria, and experimental work continued in Germany.

But by the end of 1932, it appeared that television was not making the rapid progress which had been expected. After the novelty had worn off, people began to tire of the limited programmes, and the small flickering pictures, as yet so inferior to the films. Sales of sets began to fall. In America, one company after another began to close down. In February 1933, the Columbia Broadcasting System announced that its television programmes would cease until better apparatus became available. For the time being, the announcement said, the Company would confine its television activities to experiments in the laboratory.

This was a blow to those who had hoped so much of the infant television. The cause of the fall in interest was evident: it was poor picture quality. Up until now, all television broadcasts had used 'low definition' systems. As explained previously 'low definition' means that little detail can actually be seen.

Picture Quality

In those early days of mechanical scanning, there were twelve and a half pictures or 'frames' per second, compared with the cinema's 24 frames per second. So that there was a pronounced flicker, adding to the crudeness of the low definition. At the best, only close-ups of heads, or heads and shoulders were recognisable. Outdoor scenes were not attempted except where novelty made the poor results worth while, as in the case of the Derby.

It seemed that television with quality approaching that of the

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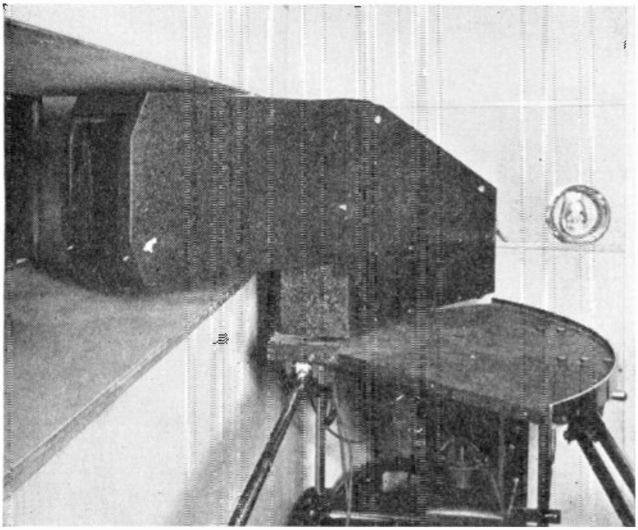

The Baird Camera in Studio BB, 1932

cinema was impossible with the existing apparatus. Baird and others in England and abroad experimented with discs having many more holes, and with more complicated mirror drums. Both had to be made very accurately and cost a great deal of money. In the case of the disc, the holes had to be kept large enough to let enough light through, and to keep the picture a reasonable size. So that more holes meant bigger discs, and because of the limits of 'eye memory' (persistence) the more holes the faster the disc had to be driven. Lighting was improved, better photo-cells were made. But with all this, there was an obvious limit to what could be achieved by mechanical means.

The 'Flying Spotlight'

For some time now, better results had been obtained by the 'flying spotlight' system. Instead of illuminating the performers with blinding lights which dazzled them and made them uncomfortably hot, they were made to perform in semi-darkness. A powerful lamp was placed *behind* the scanning disc so that a

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moving spot of light was thrown onto the scene in the studio. Thus the performers were scanned by the moving spotlight, and the light reflected from them was picked up by a group of photo-electric cells placed to one side or above or below them. See page 67). The result was similar to that obtained by the earlier method.

Baird's improved scanning methods produced 120 line pictures. Similar experiments with mechanical scanning were being carried out in America and Germany. But an entirely different television system was already on its way.

Zworykin

An English experimenter, G. W. Walton, was working on a new type of scanning, using lenses. Later this was adopted as the basis of the system called Scophony. Scophony was adopted in several countries for a time. Of far greater importance, however, was the work of two men, an American called Philo T. Farnsworth, and a Russian named Vladimir Zworykin. Both were using scanning methods which employed no mechanically driven mechanism whatever. Both used the *cathode ray tube* as the basis of their cameras.

Zworykin's work led the way to our present television apparatus. His system has in time become universal. It follows almost exactly the lines suggested by A. A. Campbell Swinton so many years before. Farnsworth's camera employed a device called an 'image dissector'. He also invented another piece of apparatus called an 'electron multiplier' which is used for television. It was a kind of radio valve used for enormously magnifying small electric currents.

Zworykin had been a student of Boris Rosing at the Technical Institute in St. Petersburg (now Leningrad). Between 1907 and 1912 Rosing had developed the idea of using a cathode ray tube for a television receiver. (See page 29). In 1912, Zworykin

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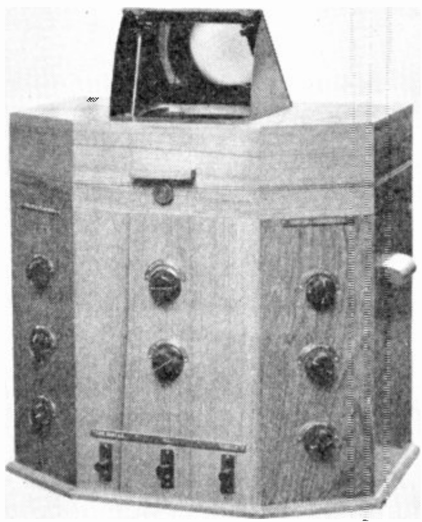
graduated, and during the First World War served in the Signal Corps of the Russian Army.

In 1919, he emigrated to America, and joined the staff of the Westinghouse Company. Quite soon he was at work on cathode ray tubes. In 1923, following the lines suggested by Campbell Swinton, he had successfully developed a cathode ray tube camera. At the time, he found difficulty in getting anyone interested in his invention.

Seeking money to develop his ideas, Zworykin approached D. Sarnoff, the head of the Radio Corporation of America, a great wireless apparatus manufacturing organisation. As a result, he was invited to work in the R.C.A. laboratories. A patent for a cathode ray tube camera was applied for in 1925 and was granted in 1928. The development of the camera then continued, and altogether, from 1923 to 1933, Zworykin worked for ten years to perfect his invention.

Zworykin's camera was later called the 'iconoscope' from the Greek word *ikon* (image) and 'scope' which means seeing. So that the iconoscope means something like 'image viewer'. Its working will be described in the next chapter. News of the development of these revolutionary television methods reached the British Government, which decided to set up a committee to examine the problem of television. In May 1934, it was announced in the House of Commons, that the committee, under Lord Selsdon, would



A cathode ray tube receiver in 1934

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'consider the merits of the various systems and . . . the conditions under which any public service could be provided'.

The committee consisted of a judge as chairman, four well-known scientists or engineers, and a high official from each of the B.B.C. and the G.P.O. Evidence was heard from well-known radio manufacturers, the Television Society, wireless magazines, the B.B.C. and the four leading television firms of the day, Baird Television Ltd., E.M.I. Ltd., A.C. Cossor, Ltd., and Scophony Ltd.

The Selsdon Report

After conducting its enquiries for seven months, the committee gave its report to Parliament. The report, which Parliament accepted, had the most far-reaching effects on British television.

The members of the committee agreed that low definition (30 line) television was of little use for entertainment. They recommended that the B.B.C. should be responsible for organising a national high definition service as soon as possible. The cost was to be met by licence fees to be paid by those possessing receivers.

In order to select the best television system, the committee recommended that two of the four systems should be tried alternately for a period.

The Alexandra Palace, showing the television station transmitting aerial

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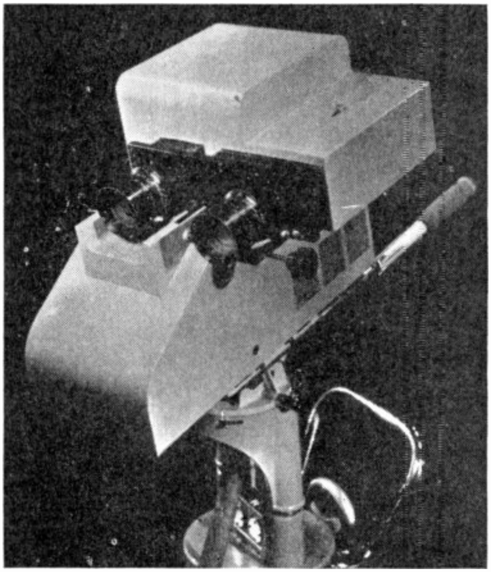
The definition was not to be less than 240 lines, 25 pictures per second. The systems recommended for the trial were those of Baird and E.M.I.

The Selsdon Committee's recommendations were acted upon without undue delay. A new wireless station specially for T.V. broadcasting was built at Alexandra Palace, London. A 220 feet high steel aerial mast was built on one of the towers specially strengthened to carry it (see page 74). The station commenced regular transmissions in 1936.

One week Baird sent out the transmissions through his apparatus. The next week it was the turn of E.M.I. Baird tried out two methods. One was the 'intermediate film' method. In this, an ordinary motion-picture film was first taken, and was then televised. By this means, the scene televised was seen by the viewer a little after it had taken place. The other method used an 'electron camera' based on Farnsworth's patents.

The 'Emitron'

E.M.I. used one method only, following Zworykin's system. Their camera was called the 'Emitron', and was a cathode-ray device based on the iconoscope. Under their Director of Research, Isaac Schoenberg, the group of E.M.I. workers had been giving their attention to receivers using cathode-ray tubes. As the receivers improved, the defects of the transmitters became more noticeable. As a result, in-



The 'Emitron' Camera, 1937

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terlacing (page 79) was introduced into E.M.I. transmitters at the time that they were using 180 line Nipkow discs. Finally, the group had decided to abandon mechanical scanning altogether, and to work on the cathode ray tube method of transmission.

This proved to be a most important decision in television history. The 'Emitron' camera, named after E.M.I., was developed between 1936 and 1938. It was an entirely British development.

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CHAPTER ELEVEN

High Definition

We can now take a look at Zworykin's wonderful invention, the cathode-ray tube camera, or 'iconoscope'. It combines many of the principles we have already read about in this book.

This television camera in common with most cameras has a lens. The lens is pointed at the scene, from which it receives light reflected from the objects. Behind the lens is a glass cathode-ray tube of a peculiar shape.

In an ordinary camera, the light coming through the lens falls on to a film inside the camera. This film is thus exposed, giving us a picture of what the lens has 'seen'. In the iconoscope, as the diagram on page 78 shows, light coming through the lens is focussed on to a plate or screen inside the cathode-ray tube. This screen is a wonderful thing. Although it is very small, it consists of hundreds of thousands of tiny photo-electric cells. It is in fact, a photo-cell mosaic in miniature.

With a magnifying glass you can focus a small upside down image of the window on to your hand, or on to a piece of paper (see page 11). The lens of the iconoscope focuses this kind of image of a scene on to the screen inside the cathode ray tube. Each tiny photo cell of the screen becomes charged with electricity, according to the strength of light falling on it.

This charge of electricity is 'collected' from each cell in turn, so that an electric current flows from the cathode-ray tube camera to the wireless transmitter. The 'collection' is carried out by making

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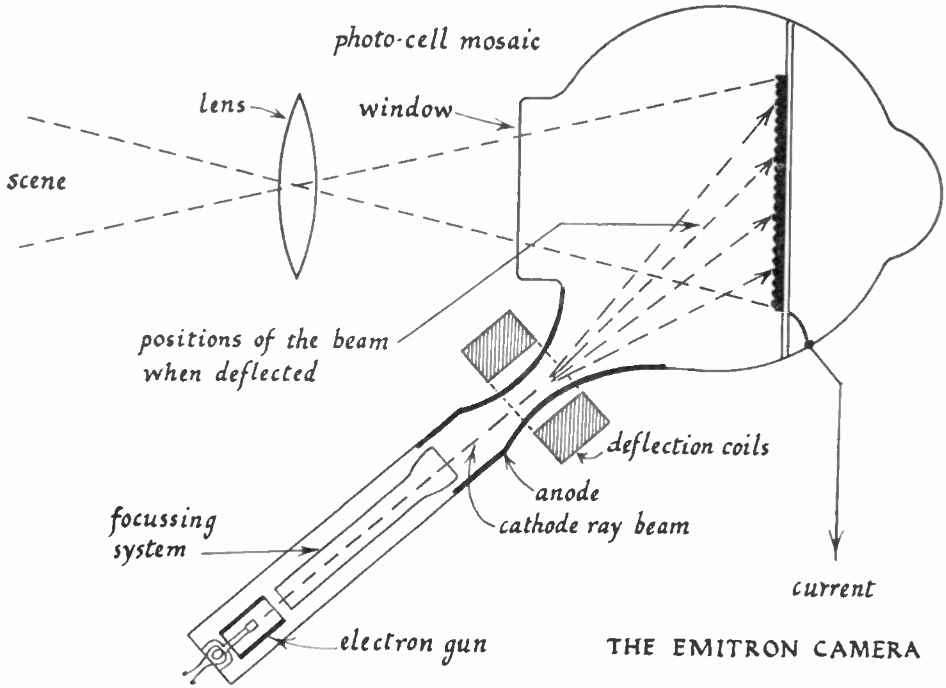

THE EMITRON CAMERA
The first really successful T.V. Camera, based on Zworykin's Iconoscope.

a thin beam of cathode rays 'scan' the screen. As this beam touches each little cell, the cell gives up its electric charge. The scanning takes place in the usual way, in lines across the screen, and there are 405 lines to each picture. The speed of the scanning is very rapid indeed. The moving cathode-ray completely scans the 405 lines in one twenty-fifth of a second! There are thus 25 pictures or 'frames' per second. (Compare this with Low Definition, page 68).

'Interlaced Scanning'

The diagram on page 79 shows 'interlaced' scanning, a method used in the 'Emitron' and other modern cameras. Each picture or

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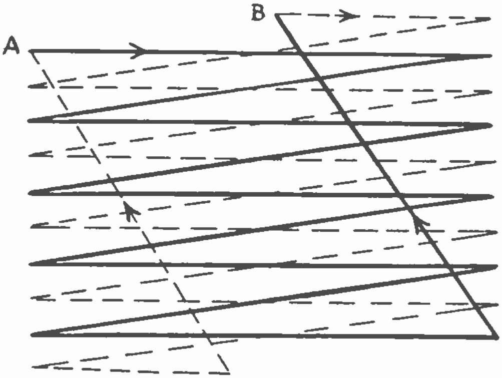
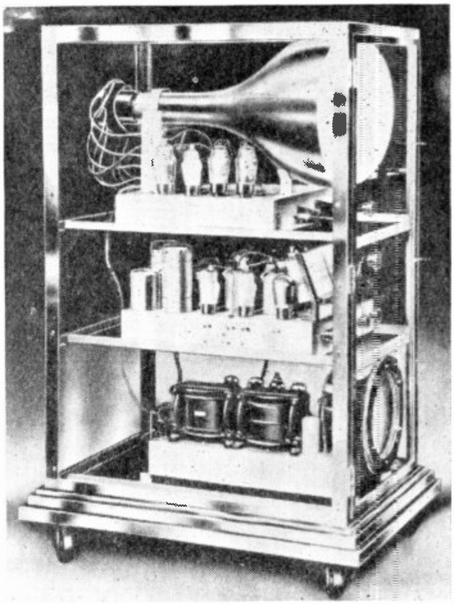


INTERLACED SCANNING

Starting at A, the beam zig-zags down, then 'flies back' to B, descending the second time in between its first lines. By this method, the number of lines per frame is halved to 202½, and the frames doubled to 50 per second. The eye receives the illusion of 405 line definition because of the interlacing, and almost entire freedom from flicker because of the 50 frames per second.

frame is scanned twice, first along the even, and then along the odd lines, as shown in the drawing. One odd and one even scan are performed in the one twenty-fifth second. This is a method of increasing the number of frames per second, without also increasing the number of lines. The eye is deceived into thinking that it is seeing fifty frames per second, which gives almost complete freedom from flicker.

The British Government, in acting on the Selsdon Report, also said that both the transmissions of the new Television Service should be able to be received by the same receiver. A new kind of receiver was put on the market. Sets were manufactured by the leading makers, such as Marconi, E.M.I., A.C. Cossor, Scophony and Baird's own company.



The first 'Cossor' cathode ray T.V. set used for high definition reception

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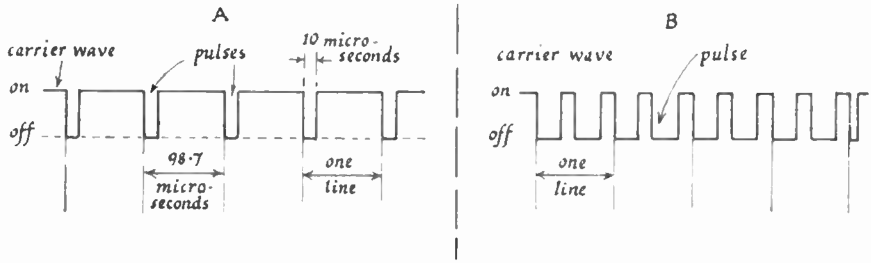
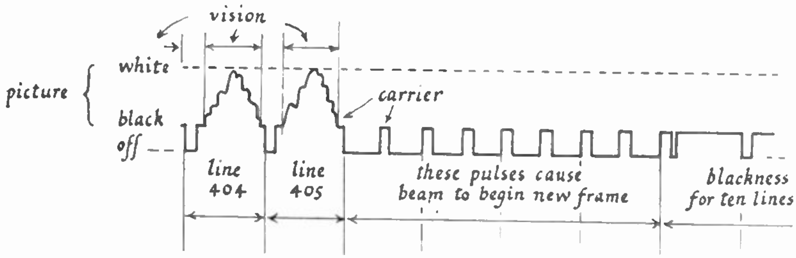


SYNCHRONISING OR CONTROL SIGNALS

A shows a radio carrier wave which is being regularly switched on and off. (The carrier frequency is not shown, only the rise and fall is drawn.) Such a carrier is received by a T.V. set, to control the *timing* of the scanning movements of the cathode ray beam. The brief 'off' period or pulse causes the beam to fly back to the left-hand side of the tube to *begin a new line*.

B shows the same radio carrier changing to eight longer 'off' pulses when the lines have reached the bottom of the picture. This causes the beam to fly back to *begin a new picture*.



THE COMPLICATED SHAPE OF A T.V. VISION SIGNAL

The diagram shows the picture and timing pulses being sent out together. The receiver separates them. The vision signal controls beam brightness, the pulses the scanning. The instant shown above is the last line in a frame.

The diagram on page 81 shows, in simplified form, the working of this type of receiver. It is, in essential, the receiver used today. Thus Campbell Swinton's prophecy was fulfilled.

The end of 30 *line T.V.*

Meanwhile, in August 1935, the B.B.C. announced the end of 30 line television. With it came to an end the era of mechanical television. The old service went off the air on September 11th

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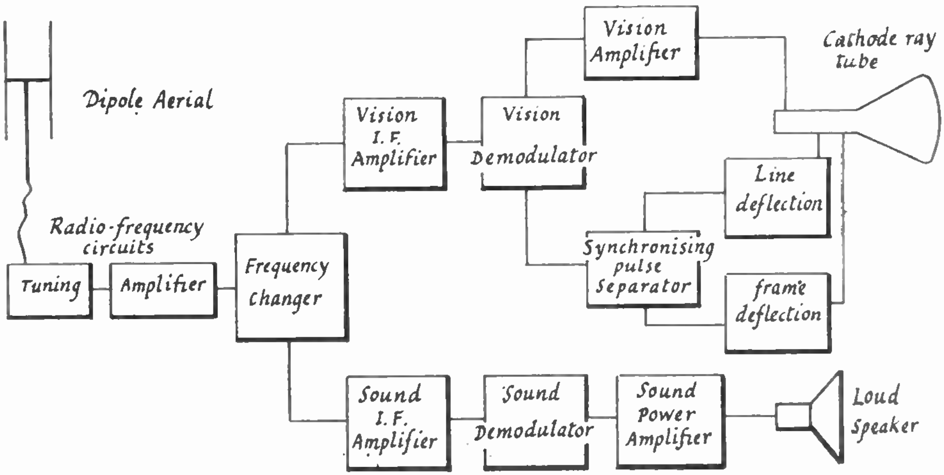

DIAGRAM OF A MODERN T.V. RECEIVER

Vision and Sound are received together, and separated at the frequency changer which also changes the high radio frequency (about 45 megacycles per second) to a lower frequency which can be more easily handled. Two amplifiers at this intermediate frequency (I.F.) then pass on vision and sound to their respective channels.

1935. Earlier in that year, in June 1935, the B.B.C. had commenced planning the new station at Alexandra Palace. Their engineer, T. C. Macnamara, who had planned all B.B.C. stations and studios since 1923, was entrusted with this work.

Abroad, the German Government claimed to have opened 'the world's first' high definition T.V. service. This service, however, did not prove to be a regular programme service like that which followed in Britain. Television was, and still is, a comparatively short range service compared with sound radio. Whilst it is possible to receive sound radio over distances of hundreds of miles, the range of a T.V. transmitter is usually about 30 to 40 miles. A national television service, therefore, meant many more stations were needed than for sound radio. The problem was far greater in America than in a small country like England.

In 1935, the Radio Corporation of America announced an experimental 343 line service from its station at the top of the

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Empire State Building. The system employed was that of Zworykin.

Experimental services were also announced about this time in France, Austria, Italy, Holland, Sweden, Russia and Japan. Some of these at first employed mechanical high definition systems. In England, Baird carried on his researches, in particular with 120 line television in colour. In 1936, still using Nipkow discs, he gave a demonstration of colour television on a big screen at the Dominion Theatre in London.

The trial period

There was no doubt, when the B.B.C. television service opened at Alexandra Palace in 1936, that Britain was leading the world in television. The first programme was timed for August 26th, the opening day of Radio Olympia, the great annual wireless exhibition in London. The steel lattice mast had been erected on the strengthened tower of Alexandra Palace. The new transmitter had been built and tested. Studios had been constructed and equipped.

A talented team of producers, studio managers, lighting experts and film cameramen got to work on preparing the programmes. The first programme was rehearsed and practised ten days beforehand. It was a revue, with a special hit song entitled 'Here's looking at you'. Other attractions included a performing horse, dancers, and the new Television Orchestra.

For the fortnight of the exhibition, a daily two-hour programme was broadcast. Over 100,000 people came to the viewing room at the exhibition, to see and hear the programme. The effect on almost everyone was tremendous. Here was real television at last.

Thus the trial period of the two systems began. At Radio Olympia, Baird's 240 line pictures had been shown, alternating with E.M.I.'s 405 line. Marconi's Wireless Telegraph Company, which had built the wireless transmitter for E.M.I., now formed a

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joint company with E.M.I., to undertake the television work of each organisation. The new company was called Marconi-E.M.I. Ltd.

Baird's Company used two studios at the Palace. In one, the intermediate film process was used. The principle of this system was described on page 75. The speed of its operation was amazing. The cinema film taken of the scene in the studio was developed, washed, fixed, washed again, and whilst still wet, was passed through the television camera. Each single frame took only 65 seconds from being photographed to being developed and televised. The television camera used an improved kind of Nipkow disc, revolving at 100 revolutions per second.

One of the difficulties with the method was that the sound, too, had to be recorded. Otherwise the voices would be heard 65 seconds before the picture was seen. The second Baird studio used a Baird 'Electron camera' based on Farnsworth's system. Each of the Baird transmissions gave a 240 line definition.

Marconi-E.M.I. used one studio only. In it they used four

Elizabeth Cowell, one of the first B.B.C. television announcers as she appeared on the screen in 1937

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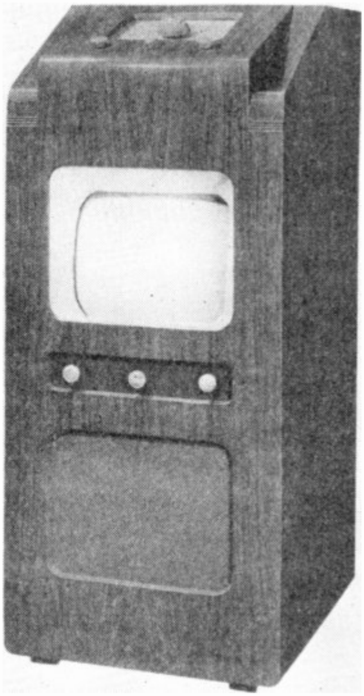
Emitron cameras mounted on mobile stands. They were thus able to take 'close-ups' or 'long shots' while the programme was in progress. There was also provision for switching from one camera to another. The definition was 405 lines. Following Radio Olympia, regular programmes officially began. The date was November 2nd 1936. Two programmes were broadcast daily, one at 3 p.m. and the other at 9 p.m.

Baird loses the battle

In February 1937, the Government's Television Advisory Committee decided between the two systems. The Marconi-E.M.I. system was chosen.



A domestic television set in 1939

Baird had lost. For him, the experience was a bitter one. The pioneer of practical television saw a different system from his triumph in the end. The modern television we know has practically nothing in common with the mechanical systems he worked on. Many people still think of Baird as the 'inventor' of television. Whilst this is incorrect, there is no doubt that he was responsible for the early start of television broadcasting.

History was unkind to Baird. It is possible, however, that the future historian may compare his work with that of Marconi. The two men have much in common. Both were engineers rather than scientists. Both used systems which later became out of date. The modern wireless trans-

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mitter and receiver have little resemblance, if any, to the spark transmitter and coherer with which Marconi first demonstrated wireless telegraphy. No doubt, Baird would have fared better if he had adopted the cathode-ray tube a few years earlier.

In spite of his setback, Baird carried on his experiments. Now, however, he devoted himself to working on big-screen cinema television and colour television. His company occupied itself with the manufacture of television sets, all of which now employed cathode-ray tubes.

The credit for the Marconi-E.M.I. success belongs to Schoenberg and his team. The leading position which Britain now occupied in the world was entirely due to their efforts. Quite independently, they had developed television cameras and methods of transmission to a standard far in advance of anything in any other country.

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CHAPTER TWELVE

The First Regular Programmes

THE programmes which followed from 'Ally Pally' until the outbreak of the Second World War were remarkable for the pioneering spirit which they showed.

Famous actors and artistes made their appearances. 'Picture Page' produced by Cecil Madden, became a regular feature. 'Theatre Page' gave excerpts from plays appearing in London theatres. Interesting items of every kind were presented. Producers began to learn the art of working for the small television screen, and of combining camera 'shots'.

Then plans were made for what was to become one of the greatest attractions of television, the televising of events outside the studio. Experiments took place first of all in the grounds of Alexandra Palace, where the studio cameras were taken out as far as their wire leads would permit. A mobile television van was ordered.

The Coronation 1937

In May 1937, there came a great opportunity provided by the coronation of George VI. Cameras had to be set up to cover part of the coronation procession. Considering the lack of experience in outside television broadcasting, the results were wonderfully successful. The B.B.C. arranged for a special cable to be laid between Hyde Park Corner and Broadcasting House, and from thence to Alexandra Palace.

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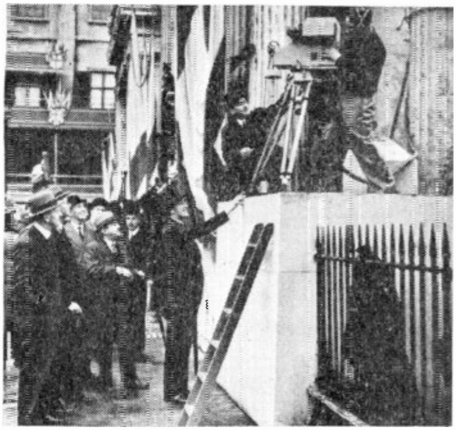
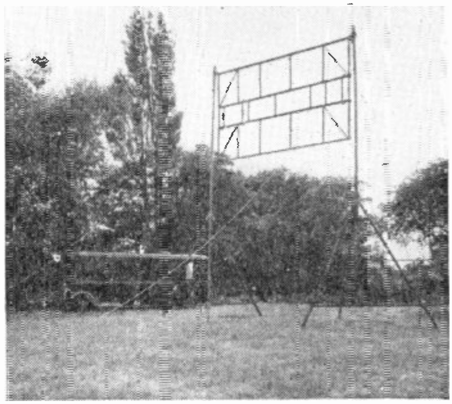


The T.V. camera at Hyde Park Corner, ready for the Coronation procession in 1937. Schoenberg is the shortest in the group, standing in the centre.



The televising of the Coronation of King George VI in 1937. The O.B. van and aerial.

A very special innovation was the new mobile van, provided with its own short wave transmitter, which could link the cameras direct to Alexandra Palace by radio. Freddie Grisewood was made the first television outside broadcast commentator.

One camera had to be placed within a few feet of the procession for close-up shots of the Royal Coach. At Hyde Park Corner, a camera was placed on the pavement, and two others on the plinth of the gate. This was to permit views of the procession being televised as it approached and went on to Buckingham Palace.

When the great day arrived, the sky was dull. By midday there was rain. All concerned with the televising were disappointed and worried. When the procession passed, however, news came through that reception had been surprisingly good.

'*O.B.'s*'. *The Boat Race*

The B.B.C. followed this success with a series of O.B.'s. They included tennis at Wimbledon, motor racing, the Armistice Day

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A B.B.C. control room, with vision in front and sound behind the partition. Notice the 'monitoring' T.V. screens showing what is happening in the studio.

ceremony at the Cenotaph, and the Lord Mayor's Show. Close-up lenses began to be used on the cameras. The first transmission of the Boat Race was in April 1938. It nearly ended in a fiasco. All the telephone lines connecting Alexandra Palace suddenly went dead just before the televising. It was discovered that a nearby roadmender had cut the main cable with his pneumatic drill. Happily, emergency measures were taken in time and the O.B. was able to carry on.

The T.V. cameras used for the Boat Race did not follow the whole of the race, but only the finish. Viewers were shown a chart on which the progress of the two crews was shown. They could

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follow what was happening by listening to the sound commentary being made. Then, as the boats came into view near the winning post, the T.V. cameras picked them up, and viewers saw the finish.

The Derby, the Test Match at the Oval, boxing championship fights, Rugby at Twickenham, and the Trooping the Colour Ceremony, were a few of the outstanding events that were subsequently televised.

From the studio there came plays, ranging from Shakespeare to modern playwrights. There were also talks and discussions, musical performances, and variety. As more experience was gained so the programmes improved.

By 1939, the number of viewers had risen to over 20,000. We must remember that so far there was only one station, with a normal range of thirty to forty miles, and that was in London. Yet Britain led the world in television by a greater margin than at any time before. British set manufacturers estimated that by the end of the year, there would be over 70,000 sets in use. In the U.S.A., and in the rest of Europe, there were no regular programmes, and there were no sets for sale!

In August 1939, at Radio Olympia, crowds once again saw the latest models of television sets. The B.B.C. devised special programmes for the occasion. There were outside broadcasts and films in the daytime. In the evenings there were plays and variety. A glass-fronted studio was also on view, enabling visitors to see the cameras and performers in action whilst the televising was going on.

In the London area, the television 'H' or 'dipole' aerial began to appear on people's chimney stacks. Sound was on 7.23 metres (or 41.5 megacycles per second) and vision on 6.67 metres (or 45 megacycles per second). The sets for sale employed cathode-ray tubes with screens approximately 8″ or 12″ wide. One could buy a T.V. receiver, combined with an all-wave radio set in one cabinet, for about £75. The high price meant that few people could afford television at that time. (A new Ford 8 h.p. car then cost £100, and a bicycle £6 10s.).

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The television industry, however, believed that, as more sets were sold, television would become cheaper, and as popular as sound radio. Plans were already in hand at the B.B.C. for building stations in the large cities in the provinces, such as Birmingham and Manchester. Large screen television had been fitted by the Baird Company in three more London theatres. Similar installations were being carried out by Scophony Ltd.

1939, *the close-down*

But by the 1st of September, international events showed that a tragedy was about to befall not only television but the world. On September 3rd 1939, the Second World War broke out. Television was closed down in England for the duration of the War.

The studio 'set', surrounded by cameras and apparatus

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Those in authority at the B.B.C. had known a few days before of the possibility that the wonderful progress of television might come to an end. The close down of 'Ally Pally' came on September 1st. The announcer at Radio Olympia finished the morning's programme with an announcement of forthcoming events. There were to be plays, outside broadcasts, new editions of 'Picture Page', films, and other attractive items. Up at Alexandra Palace, however, the worst was expected. The last thing to be broadcast was a Mickey Mouse cartoon film. This ran for about eight minutes, and ended with an imitation of the actress Greta Garbo, saying, 'Ah tink ah go home!' The shut-down order came at 12.10 p.m. The station went off the air without even a farewell announcement. When people switched their sets on that evening the screens were blank. English television had to mark time for the duration of the war.

American Television

Television did not come into existence in America as a regular service until July 1941, nearly five years behind the developments in England. Technically, the Americans were not behind, however. When commercial television at length began in 1941, a good standard of programmes was quickly achieved. America did not come into the war until that year.

On December 7th 1941, the American station WCBW was hurriedly put on the air to give a report of a fateful event. It was the Japanese attack on Pearl Harbour. The news bulletin which the television station transmitted while the attack was still continuing, gave latest news flashes and a summary of the events. These were illustrated by maps and charts.

America was now in the war also. Because of the short range of television stations, and the vast distances between America and her enemies, her television was allowed to carry on. Naturally, the programmes were influenced by the war. Television proved very

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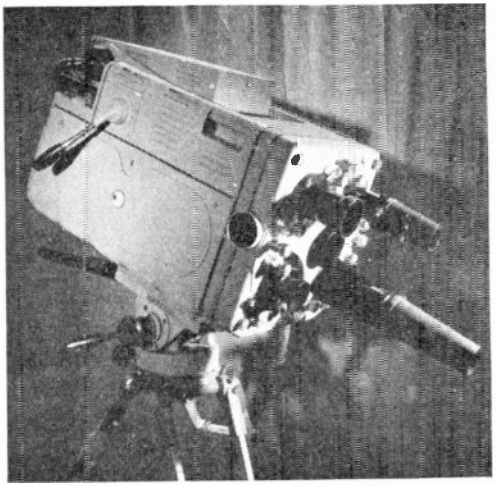

A modern T.V camera with a revolving lens turret so that the operator may select the most suitable lens for the scene (1958)

useful for giving instructions to people on air raid precautions and civil defence.

By comparison with sound radio and radio telegraphy, television was little used in actual warfare operations. Research, however, went on. An obvious use for the television camera was aerial reconnaissance. Pictures had already been successfully televised from an aeroplane. In 1940, an American aircraft circled Manhattan Island, and televised what could be seen from the air. The transmission from the plane was successfully picked up and rebroadcast from the Empire State Building station W2XBX. Another plane carrying newspaper men, flew alongside the first. In this aircraft there was a television receiver. The newspaper men were able to see on its screen a picture of their own plane in flight, taken from the other aircraft.

The Germans used television to some extent for propaganda purposes. It was discovered by British observers that the Paris television station was broadcasting news bulletins in 1942. The British were able to pick up these transmissions and gain valuable information about what was happening in enemy occupied France. Apparently, the Germans did not think that reception over such a distance was possible.

The Service re-opens

In 1943, the British Government set up a committee under Lord Hankey to decide when and how British television should

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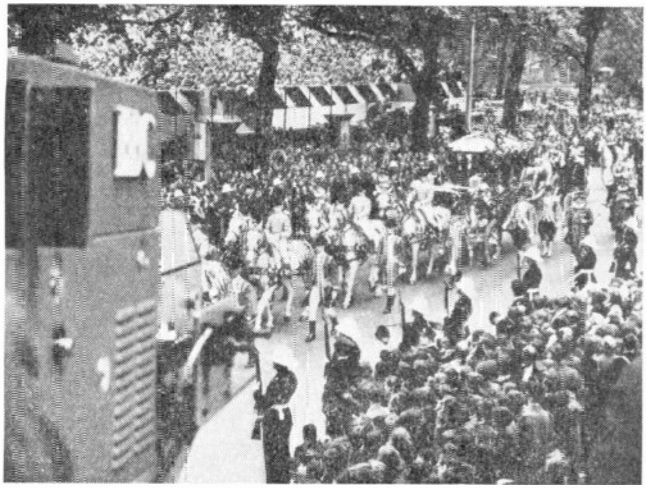

The Coronation of Queen Elizabeth II being televised, 1953

re-commence, and upon the future of the service. The recommendations of this committee were adopted by the Government in 1945. The committee had decided that there had been no great changes in television methods since the beginning of the war. It therefore recommended that the service should begin again almost where it left off, with 405 line definition.

Interior view of a mobile control van for outside broadcasts

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Alexandra Palace had escaped the bombing, although towards the end of the war, it had had a narrow escape from a V1 flying bomb. The staff had been disbanded for wartime service, and had to be got together again.

The time of reopening was June 1946. The first programme included the last item to be broadcast in 1939, the cartoon film, 'Mickey's Gala Première'. Gradually the programmes were re-started. Quite early there was a great Outside Broadcast event, the Victory Parade. Since that time the television service has greatly developed. The televising of a second Coronation, that of Queen Elizabeth II took place in June 1953. This was a particular triumph for television, and showed that in recording events it could equal the film in many respects.

Baird came into the news again in 1944 with a new system of colour television. Up to his untimely death in 1947, he had continued his study of this fascinating prospect for T.V.

I.T.A.

In 1955, after much public discussion and keen debate, commercial television was started in Britain. A new organisation called the Independent Television Authority was set up by the Government. It is organised differently from the B.B.C. Separate privately owned programme companies hire transmitting time and provide programmes. These programmes are paid for by money from advertisers. Advertisements, in the form of short films, cartoons, or announcements are included in the programmes. This system is based on that of commercial radio in America, except that in Britain, no advertiser is allowed to organise, or 'sponsor' the actual programmes.

The Present

In 1958, there were about 7,000,000 T.V. sets in use in Britain. There are now more people watching television than listening to

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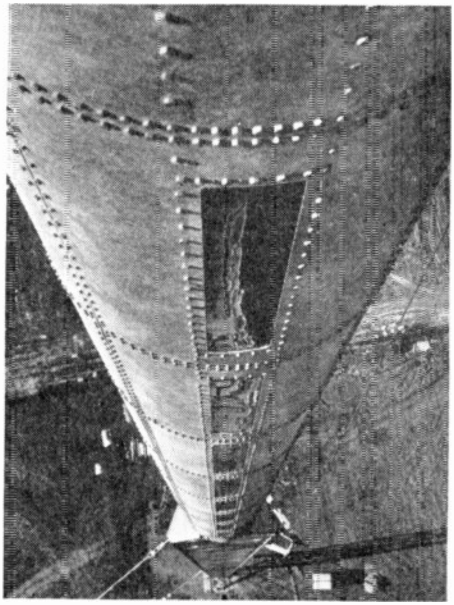
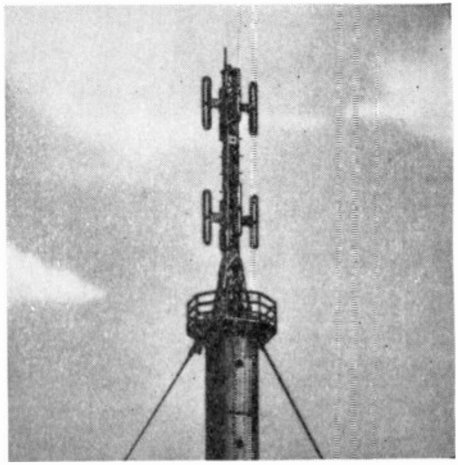
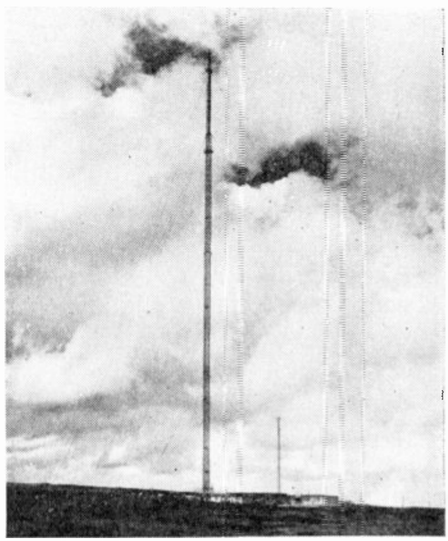




Close-up of the Sutton Coldfield transmitting aerial

Looking down the mast from the aerial at the Sutton Coldfield television station



The mast of the B.B.C. Holm Moss television station, 750 feet high.

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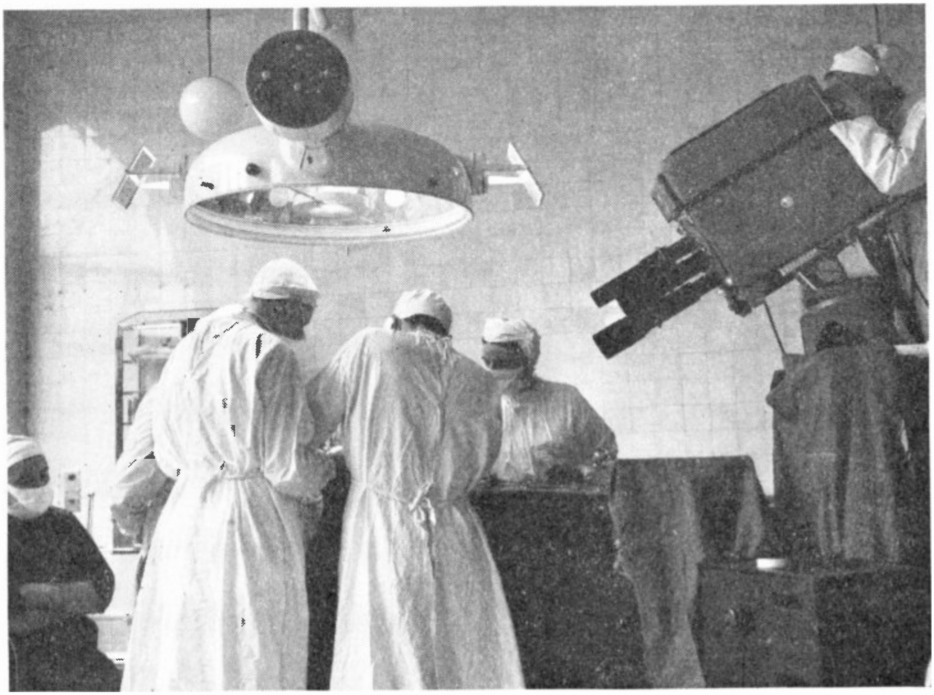
sound radio. People in most parts of the country will shortly be able to receive both B.B.C. and I.T.V. broadcasts if their sets are fitted to receive both programmes.

In Europe, several countries which began television services more recently than Britain, have adopted systems of even higher definition than 405 lines. One of these is France. There have been some very successful exchanges of programmes between Britain and Europe: the difficulty of the varying definitions has been overcome.

T.V. has been used in hospitals to enable doctors and medical students in one room to follow the progress of an operation in another. This has enabled them to see better than if they were



T.V. used in the operating theatre of a hospital

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Underwater Television. The television camera identifies the wreck of the lost submarine 'Affray' 260 *feet below the English Channel, in* 1951.

actually present. Another advantage is that, there is no need for large numbers of people to be in the operating theatre.

In 1951, the lost submarine *Affray* was located under the sea and identified by an under-water television camera. There have also been demonstrations of the television-telephone, whereby people can see as well as hear each other whilst telephoning.

Interference by motor car engine ignition systems and other forms of 'man-made static' spoils our viewing sometimes, especially if we live near busy roads. This trouble can be avoided by fitting 'suppressors' to the source of the interference, which might be spark plugs in cars, vacuum cleaners, hair-driers, electric motors or washing machines.

Colour Television

The first successful experiments with televising in colour took place as long ago as 1928. A mechanical system was demonstrated at the Bell Telephone Laboratories in America, and in the Baird Laboratories in July 1928. Baird also demonstrated his system at

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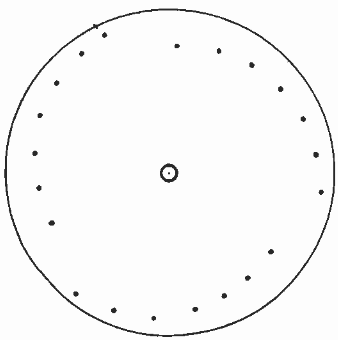
the Glasgow meeting of the British Association in the same year (see page 57.) The principle was similar to that of the 'three colour' system used in printing coloured pictures. In this system, the three primary colours are printed separately. That is, the yellow part of the picture is printed first, the red next, the blue last. The other colours are obtained by allowing overlapping of the three primary colours, for example yellow and blue to make green.

The simple colour television system used with low-definition television in 1928 had a scanning wheel with three sets of holes (see diagram). Each set was covered with a piece of coloured glass or celluloid, in this case the colours being red, green and blue. A similar scanning disc was used for the receiver.



MECHANICAL COLOUR T.V.
A Nipkow disc with three sets of holes, one for each colour, red, blue, and green.

The subject was thus scanned three times, one for each colour. When the 'red' set of holes was scanning the picture, only the light from the red parts went through to the photo cell. At the same moment, in the receiver, the red holes in the disc were moving between the lamp and the screen. The same thing happened in the case of the green and blue holes. The colours were being sent separately in succession, but because of 'eye' memory', the viewer seemed to see the three colours together. By the apparent mixture of the coloured lights, the full colours of the picture were obtained.

Later on it was discovered that photo-electric cells could be made which themselves were more sensitive to a certain colour than any other. Baird devised no less than four different systems of colour television. The last, which he demonstrated in 1944, was based on a 'double' cathode ray tube. In this tube was a two-sided screen, the back of which was coloured blue-green and the other

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Colour Television.
The camera used for a mobile hospital unit

side red. Two cathode-ray beams were used, one to work on the blue-green side and the other on the red. As the screen was transparent the viewer saw both sides together, giving the full colour effect.

Since that time, there have been experiments with different systems of colour television, on both sides of the Atlantic. In 1958, demonstrations of large-screen colour television of very good quality and high-definition were given by the Marconi Company. This was used over a line from a hospital operating theatre, permitting a greatly *enlarged* view in colour of the surgeons' work to be seen in another room.

At present, colour television is not yet being generally used in television broadcasting. Although it is now technically possible, many problems still remain, chiefly those of cost and the difficulty of adapting existing receivers. But in the same way that Technicolor and other colour systems have been successfully used for cinema films, a system of colour television broadcasting will almost certainly come in time. The future may also hold in store for us stereoscopic colour T.V. ('3D' or three dimensional colour) with stereophonic sound!

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TIME CHART

1800 **The Electric Battery.** Alessandro Volta (Italy) discovered the simple electric cell.

1802 **The Steam Ship.** William Symington (Scotland) built the 'Charlotte Dundas'.

1804 **The Steam Locomotive.** Richard Trevithick's steam engine pulled trucks along a Welsh tramway.

1816 **Selenium** discovered by Jöns Jakob Berzelius (Sweden).

1819 **Electro-Magnetism** discovered by Hans Christian Oersted (Denmark).

1825 **The Electro-Magnet** made by W. Sturgeon (England).

c.1826 **Photography.** The first plate made by Nicephore de Niepce (France).

1831 **The Dynamo** invented by Michael Faraday (England).

1832 **The Electric Telegraph** developed simultaneously by Samuel Morse (America) and Paul von Schilling (Germany).

1839 **Light and Electricity.** The electro-chemical effect of light discovered by Edmond Becquerel (France).

1845 **Light and Magnetism.** Michael Faraday (England) discovered the effect of magnetism on polarised light.

1850 **Submarine Telegraph Cable** laid from England to France.

1866 **Trans-Atlantic Telegraph Cable** laid between England and America.

1873 **Wireless Waves** predicted by James Clerk Maxwell (Scotland).

1873 **Light Cell.** Willoughby Smith (England) discovered the effect of light on selenium.

1875 **The Kerr Cell** a device for controlling light by magnetism discovered by John Kerr (Scotland).

1876 **The Telephone** invented by Alexander Graham Bell (America).

1876 **The Gramophone.** The 'Phonograph' invented by Thomas A. Edison (America).

1876 **The Microphone** invented by David Hughes (England).

1878 **Cathode Rays** generated by Sir William Crookes (England).

1878 **The Electric Lamp.** The filament lamp demonstrated by Joseph Swan (England).

1878 **'Seeing by Electric Telegraph'.** The 'Telectroscope' designed by M. Senlacq (France).

1884 **The Scanning Disc** invented by Paul Nipkow (Germany).

1885 **The Motor Car** developed independently by Carl Benz and Gottlieb Daimler (Germany).

1888 **Wireless Waves** generated and detected by Heinrich Rudolph Herz (Germany). He also discovered the principle of the **Photo-Electric Cell.**

1889 **The Cinema Film** developed by T. A. Edison (America).

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TIME CHART

1894 **Wireless** a practical system for sending and receiving wireless waves was demonstrated by Sir Oliver Lodge (England).

1895 **The Cinematograph** invented by Louis Lumière (France).

1896 **Wireless Telegraphy.** Demonstrated by Marconi (Italy) on Salisbury Plain, England.

1897 **The Cathode Ray Tube.** The forerunner of the modern tube made by Carl Braun (Germany).

1901 **Trans-Atlantic Wireless Signals.** Marconi sends letter 'S' by wireless telegraphy from England to Newfoundland.

1903 **The Aeroplane.** First flight of the Wright Brothers (America).

1904 **The Wireless Valve** invented by Sir Ambrose Fleming (England).

1906 **The Valve Amplifier.** Lee de Forest (America) invented the three electrode valve.

1907 **Television Receiver** using cathode ray tube patented by Boris Rosing (Russia).

1907 **Wireless Telephony.** Experiments in Europe and America in sending sound by wireless.

1908 **Television.** A. A. Campbell-Swinton (England) proposed the modern system of transmission and reception using cathode ray tubes.

1920 **Broadcasting** began in America, from Detroit and Pittsburgh.

1921 **Broadcasting.** The first advertised programme broadcast in England from Chelmsford.

1925 **Television Camera.** Rosing's pupil, Zworykin, patented cathode-ray tube camera, 'Iconoscope' in America.

1925 **Mechanical T.V.** The sending of silhouettes demonstrated by J. L. Baird (England) and C. F. Jenkins (America).

1926 **Low Definition T.V.** Baird demonstrated the televising of people.

1928 **Trans-Atlantic T.V.** Baird transmitted televised images of people from London to New York.

1928 **Colour Television.** Simple mechanical system demonstrated by Baird in London.

1932 **Regular T.V. programmes** using a low definition mechanical system opened by the B.B.C.

1932 **High Definition T.V.** Isaac Schoenberg and his group developed the E.M.I. 405 line system in England.

1936 **B.B.C. Television.** Experimental transmissions began, using Baird and E.M.I. systems alternately.

1936 **First Regular High Definition T.V. Service** begun by B.B.C. in England in November.

1941 **T.V. in U.S.A.** Regular 'Commercial' T.V. services began.

1955 **'I.T.V.'** Independent Television Authority formed in England.

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CASTLES
MEDICINE
MOTOR CARS
LIGHTHOUSES
INLAND WATERWAYS
TELEVISION
HOMES

People's Jobs Series

THE POSTMAN
THE ENGINE DRIVER
THE FARMER
THE POLICEMAN
THE FIREMAN
THE AIRLINE CREW
THE SHIP'S CREW
THE COAL MINER
THE DEEP-SEA FISHERMAN
THE ZOO KEEPER

How Things are Obtained Series

WOOL
TEA
GLASS
CHOCOLATE AND COCOA
IRON AND STEEL
PLASTICS
PETROLEUM
TIMBER

What Can You Find Series

IN A WOOD
IN HEDGE AND FIELD

What Causes Things Series

WEATHER
UNSEEN FORCES

How to Explore Series

CHURCHES
A TOWN
A VILLAGE
A PORT

How Things are Made Series

A HOUSE
NEWSPAPERS
RADIO AND TELEVISION PROGRAMMES

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Other titles are in preparation

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