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opening extract from

How Nearly Everything was Invented

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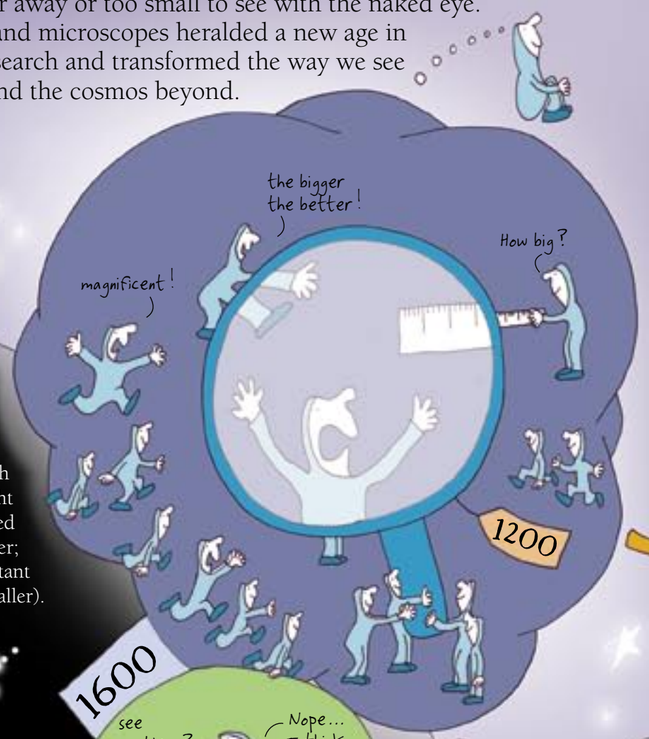
SEEING IS BELIEVING

Lenses were probably invented in China over 1000 years ago. They appeared in Europe in about 1270, where they were originally used in spectacles and magnifying glasses to improve vision. By the 17th century they were being incorporated into powerful new instruments designed to view objects that were either too far away or too small to see with the naked eye. Telescopes and microscopes heralded a new age in scientific research and transformed the way we see our world and the cosmos beyond.



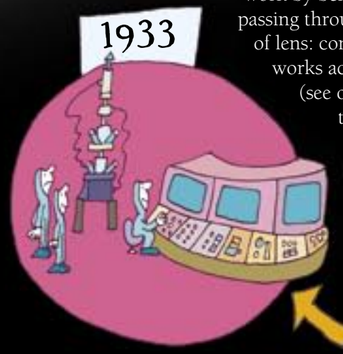
Beyond belief

In 1609, Italian astronomer Galileo Galilei became the first person to view the heavens through a telescope. But he soon got into trouble when he claimed his observations showed that the Earth revolved around the Sun, contradicting the Church's belief that the Earth was at the centre of the Universe. He was thrown into jail, under threat of death, until he took it all back!



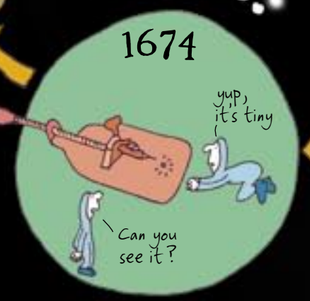
Lenses

Lenses are curved pieces of glass that work by bending, or refracting, light rays passing through them. There are two types of lens: convex and concave, each of which works according to the way it bends light (see opposite). Convex lenses are used to make small objects look bigger; concave lenses make distant objects look closer (but smaller).



Electron microscope

Powerful light microscopes can only magnify up to 2,000 times, and as the magnification goes up, the sharpness of the image goes down. So in 1933 German physicist Ernst Ruska invented a new kind of microscope that used an electron beam instead of light, which gave much better definition. Modern electron microscopes magnify over a million times to show molecules.



Leeuwenhoek's microscope

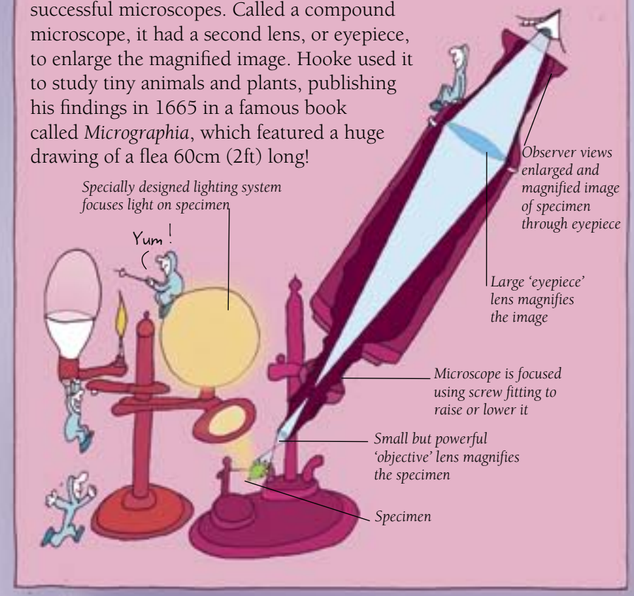
Dutch draper Antoni van Leeuwenhoek built at least 247 single-lens microscopes. They were so powerful that, in 1674, Leeuwenhoek became the first person to see bacteria, taken from inside his own mouth.

Compound microscope

The compound microscope – that is, a microscope with two or more lenses – was probably invented by Dutch spectacle-maker Hans Janssen in about 1600.

Microscopic enquiry

English scientist Robert Hooke built one of the first successful microscopes. Called a compound microscope, it had a second lens, or eyepiece, to enlarge the magnified image. Hooke used it to study tiny animals and plants, publishing his findings in 1665 in a famous book called *Micrographia*, which featured a huge drawing of a flea 60cm (2ft) long!





Refracting telescope

In 1608, Dutch spectacle-maker Hans Lippershey built what is often regarded as the first telescope, based on his discovery that a pair of lenses could make distant objects look closer. He called his invention a "looker" and thought it might be useful in warfare. Galileo built his own telescope (seen here) the following year.



Reflecting telescope

Early refracting or lens-based telescopes gave images with coloured edges. In 1663, Scottish mathematician James Gregory solved this problem by swapping the objective lens for a concave mirror. He'd just invented the reflecting telescope! Five years later, the famous British scientist Isaac Newton designed his own model (shown here) to view the stars.



Herschel's telescope

In 1789, British astronomer William Herschel built the largest reflecting telescope of his day. Almost 12m (40ft) long with a 1.2m (4ft) mirror, it was so big it had to be supported on scaffolding and moved around on circular tracks to view different parts of the night sky.



Chandra space telescope

A new kind of telescope was launched into space in 1999. Forming part of NASA's Chandra observatory, it is designed to collect X-rays and is used for studying supernovae, black holes, and dark matter.



Hubble space telescope

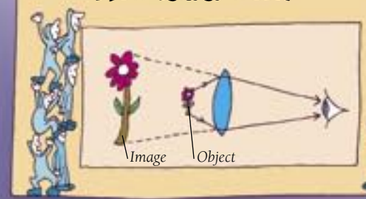
In 1990, the Hubble space telescope was launched into orbit to study emissions such as ultra-violet light that don't penetrate the Earth's atmosphere. It can view objects up to 10 billion light-years away, seeing much further into space than Earth-based telescopes.



Radio telescope

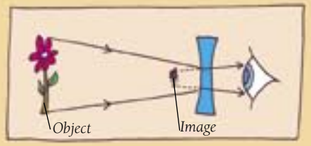
US radio engineer Grote Reber built a new kind of telescope in his back garden in 1937. Designed to collect radio waves instead of light waves, and therefore show aspects of the Universe not visible to the eye, his radio telescope was the only one of its kind for almost 10 years.

How lenses work



Convex Lens

A convex, outward curved lens bends light inwards, making an object look bigger and further away than it actually is.



Concave Lens

A concave, inward curved lens bends light outwards, making a distant object look smaller and closer than it actually is.