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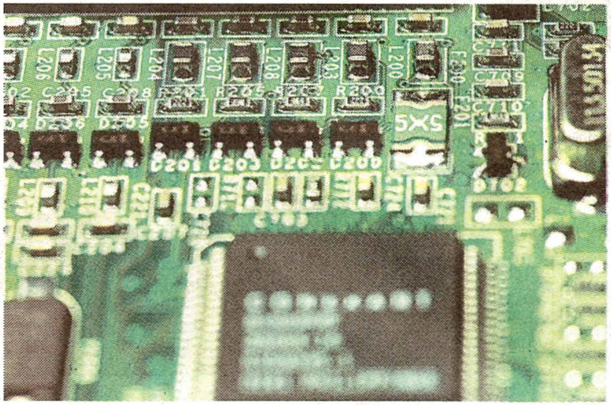
CUTTING EDGE Fibre optic cables, digital cameras and the microchip have all impacted daily lives. GETTY IMAGES



Changing lives

TECHNOLOGY Inventions like the fibre optic cable, the Charged Coupled Device (CCD), colour photography and alloys such as Invar and Elinvar have made an impact on the way we live. **C Sivaram** talks about Nobel Prizes for Physics awarded over the years for work that has made a huge impact on daily life.

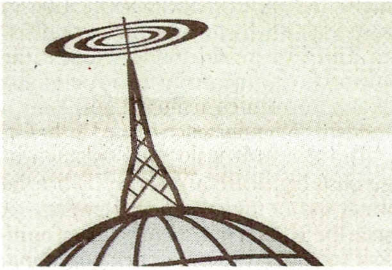
The Nobel Prize for Physics last year was given for work done several decades ago which led to considerable technological impact on day-to-day activities on a global scale. Half the prize was given to Charles Kao for his pioneering work on the transmission of light in optical fibres. Fibre optic cables have transformed the world creating a telecommunication revolution. There is enough optical fibre to circle the earth more than 25,000 times. This enables text, speech and film to be scurried across the Internet at literally the speed of light.

The pioneering work of Kao along with George Hockham appeared in 1966 in Proceedings of IEEE. They wrote: "A fibre of glassy material in a cladded structure represents a practical optical wave guide as a new form of communication."

They found that impurities in the fibre were absorbing and scattering light and this led to substantial signal losses. It was suggested by Kao that optical fibres with high purity glass could be the right candidates for efficient optical communication. He calculated that the attenuation (loss of signal strength) could be as small as a few decibels over a kilometre path. The figure is less than a fifth of a decibel per kilometre. Light can be confined in the core of the optical fibres over many kilometres by using the property of total internal reflection. Fused silica was shown to have many of the required properties enabling the making of the required properties that help in designing fibres with low attenuation.

Photography goes the CCD way...

The other half of the 2009 physics prize was shared by Willard Boyle and George Smith for their work done in Bell Labs, for inventing the 'Charged Coupled Device', better known as CCD. While Kao's work revolutionised the communication of all information by light, the CCD created another revolution in the storing of information carried by photons. The imaging semiconductor circuit underlies the basic design of most digital cameras now in vogue. Boyle was Smith's boss in Bell Labs. The CCD consists of millions of light sensitive cells arranged in many rows and columns. The images are reconstructed through the con-



tent of each of the pixels. This revolutionised photography, because there was no longer the need to develop negatives.

Crucial in astronomical applications

Above all, CCDs are of crucial importance in astronomical applications. Stunning, spectacular images of distant objects in the Universe obtained by instruments on board the Hubble Space Telescope over the past 20 years would have been impossible without CCDs. Crystal-clear pictures of distant celestial objects obtained by Hubble, apart from large ground based telescopes (like the Keck), have led to major developments in our understanding of the Universe. In a sense, it is fitting that the invention of the CCD was recognised in the International Year of Astronomy.

The device has also revolutionised medical imaging and diagnosis, along with a host of industrial and common commercial applications in daily activities (including the entertainment industry).

If one scans through the list of Nobel Prize for Physics that have had an impact on technology, one cannot miss the 1909 Prize shared by G Marconi and Ferdinand Braun for their pioneering work in wireless or radio telegraphy. This revolutionised radio communication followed by television, radar etc.

Hundred years later, in 2009, the prize was given for revolution in optical communication. Corresponding with the award for CCD is the physics prize of 1908, given to Gabriel Lippman for developing the technique of colour photography.

This marked the end of the drab black and white photograph era of the nineteenth century.

A limitation of the method is due to

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colour distortion and temperature effects. The theory was later presented by Fermi.

Of radio waves

Marconi was not dissuaded by physicists who told him that radio waves would not curve around the globe but would go off into space. So it became clear that his success implied that something must be reflecting the radio waves when going through the earth's atmosphere. This led to the later discovery of the ionospheric layers enabling Appleton to get the 1947 Physics Prize. The 1912 Physics Prize was given to Swedish scientist Gustav Dalen for developing the acetone-based valve which led to safe automatic lighting of lighthouse. It raised many eyebrows (he was the first Swede to get the Physics Prize).

Alloys find use in spacecraft screens

The 1920 prize was given to C E Guillaume, which was another unusual prize, in that it was given for his development of nickel-steel alloys like Invar and Elinvar. These alloys did not undergo thermal expansion when heated maintaining invariant length and elastic properties like the Young's modulus. Although awarding of the prize was criticised, invar has a host of current applications ranging from instruments in the Cassini spacecraft to flat screen TV!

In 1987, Bednorz and Muller shared the award for their discovery of a superconductor with unusually high critical temperature. In 1986, Gerd Binning and H Roehrer got half the prize for the Scanning Tunnelling Electron microscope which was just finding applications at the time. The 1956 prize was given for the invention of semiconductor of the transistor to Bardeen, Shockley and Brattain. Of course this was based on a good understanding of semiconductor physics. The prize in 2000 was given to Jack Kilby, the father of the microchip, the first monolithic (integrated circuit) for microelectronics. The other half of the 2000 prize was given to Zhores Alferov and Herbert Kroemer for their development of semiconductor heterostructures used in high-speed electronics.

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