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Optical Fibres

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***Abstract* – Optical Fibre is a flexible, transparent strand made up of very pure glass, the glass acts as a light pipe to transmit light from one end to the other end of fibre. The core of the optical fibre is surrounded by a cladding layer, made up of dielectric material. Stephen William Hawking once said - "Optical Fibre will lead an example for all loss less communication in mere future including IC technology. "Optical fibres cause minimum dispersion and has less attenuation value. The ultra-pure glass of fibre exhibits high tensile strength and extreme durability. Optical fibres are suited for carrying digital information.**

***Keywords* – Total Internal Reflection (TIR), Optical fibre communication (OFC) and Integrated Circuit (IC).**

I. INTRODUCTION

Today's era is known as "Age of Technology". The brilliant inventions and discoveries have changed the overall view of life. Though the development in all sectors has contributed to this but the ability to transfer the data more easily and quickly is more responsible for this evolution. The transmission of the data which was done using copper wires in early days is done now by using optical fibre. The data can be transferred easily and quickly using fibre optics. An optical fibre is a glass or plastic wire that carries the light along its length. Optical fibres are widely used in fibre optics communication due to its ability to transmit the data over long distances and at high bandwidth while reducing the loss of signal. Optical fibres are also immune to the electromagnetic interference created during thunderstorm.

II. HISTORY OF FIBER OPTICS

Daniel Colladon Experiment - In the year 1841, Colladon in a lecture hall wanted to show the fluid flow through various holes of a tank and the breaking up of water jets but couldn't so to solve this problem he used a pipe to direct the beam of sunlight through a tube to the lecture table. The light caused the TIR effect resulting in the light in liquid to follow the curvature of the water flow. "On the reflections of a ray of light inside a parabolic liquid stream" was published in the year 1842 by Daniel Collator.

Collator first di scribed thus as "light fountain " or " light pipe". In 1870, John Tynan performed an experiment showing the guiding of light by refraction in his public lecture in London. Alexander also invented an optical voice transmission system called photo phone in the year 1870.

John Tyndall Experiment - To show that the light follows a curvature path due to internal reflection Tyndall used a water jet that followed water from one container to another container and a beam of light. Tyndall directed a beam of sunlight at the path of water which poured out of the first container. The light followed a zig-zag path inside the curved path of water.

Alexander Graham Bell Experiment - Bell used the special mirrors to reflect the sunlight onto a diaphragm attached with a mouthpiece of the photophone. At the other end, a light-sensitive selenium resistor is mounted within a parabolic reflector, the resistor is then connected to a battery that was wired to a telephone receiver. To reflect various intensities of light in on selenium resistor Bell spoke into photo phone causing the diaphragm to vibrate and generate various intensities of light. Due to the change in intensity of light the current passing through telephone receiver also altered which then converted the light back into speech.

In 1920s Clarence Hansell demonstrated the image transmission through tubes using radio experimenter and John Logie Bird performed the same experiment using television pioneer. In 1930s Heinrich Lammas transmitted images through a bundle of unclad optical fibre. Bram Van Heel, a Dutch scientist first performed the image transmission through bundles of optical fibres using a transparent cladding in the year 1953 showing how information can be transferred using optical fibres.

In 1956 Brian O'Brien devised the first practical all-glass fibre. In 1963 Jun-ich Nishiyama was the first to propose the use of optical fibres for communication. In the present time, optical fibre is the most effective way of communication.

III. WORKING OF OFC SYSTEMS

In the field of communication OFC (optical fibre communication) systems have a brought a great change. Earlier copper wires were used to transmit the data which caused the loss of the data to lower the loss of data we use optical fibres. The system transmits the information by

sending pulses of an infrared light through optical fibre to travel long distance. At the other end a light sensitive device (photocell or light detector) detect the upcoming pulse. The electric pulse is then amplified and reshaped back into the digital form. In this process we need to convert the electrical signal into optical in the start and at last the optical signal into electrical signal.

IV. APPLICATION OF FIBRE OPTICS

Though the main use of optical fibre is mainly in the field of communication there are some other fields also in which optical fibres are used.
In Medical Industry -When the physical characteristics and versatility of optical fibre is combined in remote sensing it is possible to use it for biomedical application. It can be used to make fibre - optic biomedical sensors. The main application of fibre optic in medical field is in small, compact instruments used for performing surgeries or diagnosing patients. Fibre optics are used for the imaging and illumination components of endoscope. It is also used for remote spectrophotometry, pressure and position sensing, or scintillation counting.

In Defence Purpose -The main reason optical fibres are used in aerospace and defence is due to its safe feature i.e. its resistance to withstand harsh environment capability like high temperature, chemical corrosion, high pressure, high voltage, EMI and lightning environments. It is also used as hydrophones for seismic waves and SONAR. The optical fibres are used for wiring in aircraft and submarines. The military uses fibre optic products throughout their land-based faculties. It is also used for communication between shipboard, between ship and shore and deployable tactical communications.

In Industries -Beside telecommunication companies' optical fibres are also used in auto industry as cables and in computer networks as fibre optic. The cable is used in lighting in both interior and exterior of the vehicle. The fibre optic networks allow better data connectivity and capacity. In computer and IT based companies use the light - based signals to get data into or out of the sources or processes which store the data. Fibre optics are frequently used in smart factories, to issue and receive information and commands in real-time. It is also used to provide safety in the industrial machinery.

In Broadcasting -Fibre optic transmission started in television industry in the mid-1980s. Fibre optics are used for production and distribution of video and audio signals. The optical multiplexing is used to combine wavelength of eight videos onto one fibre. Fibre optics provides a better signal to noise ration and great immunity to interference, this way minimising the loss of data. Optical fibres are used for real-time studio monitoring for editing, general board cast, post production, station networking, uncompressed transport, multichannel distribution and many more things.

In Mechanical Inspection -Engineers use optical fibres to detect the faults and damages in the structure to reach places which are hard to reach physically. It is also used by plumbers for the inspection of the pipes. Fibre optic sensors are used to sense stress and temperature. They are also used to monitor cracks, moisture, welding residual and bridge. It can be used to determine the accuracy of the structure and to determine the quantity of parameters. Fibre optics sensors are flexible and adjustable.

In communication -In today's era the fibre optic communication system is most wide used for the transfer of information. Fibre optics provides infrastructure to the system like Ethernet and it also helps in general way of broadcasting and broadcasting distribution. Fibre optical communication has enabled higher data rates, lower levels of loss of data and much greater distances. It is used to send telephone signals. Earlier copper wires were used for the communication purpose but now a days mostly optical fibre is used. Optical fibre has made the transfer of data easy and quick. The cables are used to transfer the information to different places.

V. LIMITATIONS

Optical fibre can only be used on the ground i.e. It cannot be used for mobile communication.
It is difficult to tap optical fibre because it does not produce electromagnetic energy.
It has limited bend radius (about 30 mm). If it is bent more, it leads to the signal loss.
The splicing and testing equipment's are very expensive and cannot be used all time.
Communication is not totally in optical domain meaning the repeated electric to optical to electric conversion requirement.

VI. CONCLUSION

The use of optical fibres is very wide and there are some shortages in its use also. There are more development possibilities in optical fibres which are going on. The future of communication is based on optical fibres and the research on how to make it better is going on. They are many more ways optical fibres can be used and discoveries regarding that are going on. To study communication it is important to understand fibre optics.

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