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Transmission of Solar Energy using Fiber - Optics

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***Abstract*: India is the world's third-largest producer and consumer of electricity. India produces 37% of total electricity from renewable sources of energy and the rest from non-renewable sources of energy. India is about to leapfrog fossils fuels to generate all the growth in their electricity supply from renewables. The solar light can be harvested, concentrated, amplified,and distributed indoors by fiber optics to replace most of the electrical lighting. The whole system automatically tracks the intensified sun rays with the help of an electrical sensor and microprocessor. According to the intensity of sunlight, the parabolic reflector will maintain its position to transfer the maximum sunlight. The system is equipped with biaxial trackingmovements. The Parabolic Reflector or dish will act as a sunlight concentrator which will reflect sunlight to the mirror i.e. focus of the reflector. Other than energy and capital saving this system is also good for the psychological health of the citizen. To carry out fiber optics daylighting system many aspects are needed to consider like the climatic condition of the earth, rotation of the earth about its own axis. This paper is going to highlight the fiber optics daylighting system along with the automatictracking system.**

Keywords: Daylighting, Optical Fibers, Solar Collection, Solar Concentrator, Solar Tracking.

INTRODUCTION

The consumption of electrical energyis increasing day by day due to rapid industrialization and urbanization. Therefore the consumption of fossil fuels and other non-renewable sources of energy are also proliferating. Daylighting system can partially help in reducing the consumption of non-renewable sources of energy. Moreover,conventional candescent and fluorescent lamps have been indicated in aggravating depression, aggression, eye strain, reduced muscle strength, obesity, anddiabetes. Therefore the day - lightning system must be installed in indoors and libraries to reduce the psychological impact. After a study, we've found that at least four fiber- optic daylighting systems already exist. It's Himawari, Parans SP3, HSL (Hybrid Solar Lightning), and Solux. The three systems utilize Fresnel lenses to concentrate the light and one utilizes a parabolic mirror. To maximize their potential all these systems employ precise manual solar tracking devices. The purpose of this paper is to improve the working of the daylighting system and fabricate an automatic tracking system. In our proposed system we are going to usethe parabolic reflector in which a concave mirror will be attached. Sunrays will fall on the surface of themirror and will be redirected to focusof the mirror. A coupler is attached tothe focus whose work is to inline the sunlight and optical fibers. Three stands are attached in a parabolic mirror dish to support the focus and coupler. many types of optical fibersare available that can be used but the four core and six core optical fibers are recommended to maintain cost- effectiveness. To maintain the efficiency of the system a Light Dependent Resistor (LDR) is used which works on the principle of Resistance. Along with the LDR sensor, a microprocessor is also attached which will give the command to rotate the parabolic mirror dish towards the higher intensity sunlight with the help of a motor.

PARABOLIC REFLECTOR

The parabolic reflector works on the phenomenon of the reflection in spherical mirror which is based on the principle of optics. In the parabolic dish, a concave mirror is attached to its surface. And according to the law of reflection whenever light strikes on the surface of the concave mirror parallel to theprinciple axis it will reflect to thefocus of mirror as shown in fig.1. Thesame reflected light is projected into optical fibers through a coupler. The dish is generally connected to the stand which acts as a base wherever we mount it. The stand is connected to the servo motor which helps us inrotating the parabolic dish.

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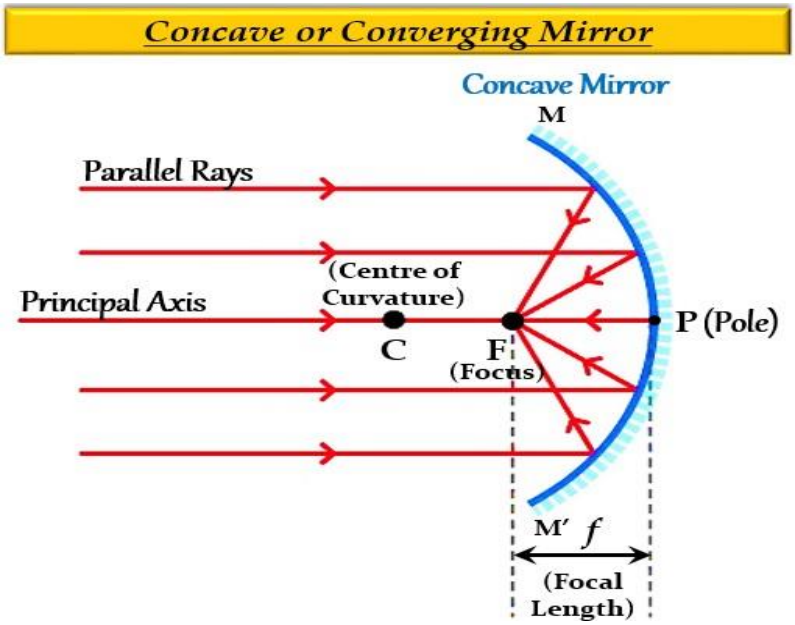

Fig.1. Law of Reflection

OPTICAL FIBER

Optical fibers work on the phenomenon of Total Internal Reflection (shown in fig.2) which occurs at the interface of the core andthe cladding provided that the angle of the incident light inside the core ishigher than the angle called the critical angle. Therefore the incident light will get reflected into the core and propagate along with the fiber. If the light strikes the interface at an angle greater than the critical angle, it will not pass throughthe other medium. Fibers generally consist of one core, one cladding, anda protective coding. It is evident fromfigure 3. That optical fibers are consist of four parts i.e. Glass core, Glass cladding, plastic buffer and the Outer jacket. A cylindrical shapedcore section is made up of dielectric material having a definite refractive index.

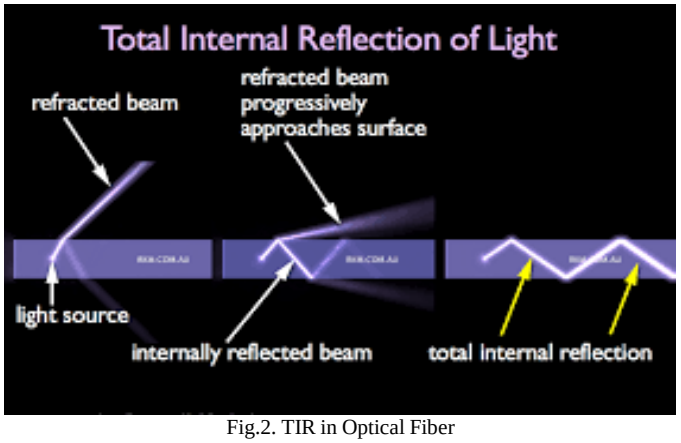

Fig.2. TIR in Optical Fiber

The core section is surroundedby the cladding section which is made of glass or plastic with a lowerrefractive index than the core section.The fundamental role of cladding in optical fiber is to reduce the loss of light from surrounding air. The cladding section is surrounded by anadditional elastic layer as buffermade of plastic which protects the optical fiber from physical damage and scattering losses caused by the micro bending. The last layer is the jacket layer which is used to recognize the type of fiber. Most fibers are made of quartz glassbecause of their purity.

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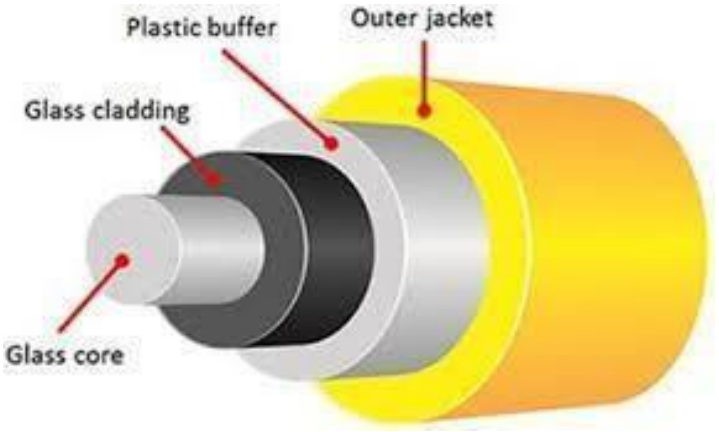

Fig.3. Parts of Optical Fiber

TYPES OF OPTICAL FIBER

To understand the key role of theoptical fiber in daylighting system wefirst need to study about the characteristics of the optical fibersbased on the classification then only we use the appropriate optical fiber indaylighting system. Basically, the optical fibers are classified on thebasis of mode. There are two types ofoptical fibers i.e. single-mode and another is multi-mode. The multi- mode optical fiber is further classified into step-index mode and graded-index mode (shown in fig.4).

Single Mode: It is a single strand ofglass fibers that allows only one beam of the light signal to propagate.The core diameter of single-mode optical fiber is of 8micron. It is expensive in cost and is generally used for reducing dispersion.

Multi-Mode: Multi-mode fiber is a type of optical fiber designed to carry multiple light rays or modes simultaneously, each at a marginally different reflection angle inside the optical fiber core. Multi-mode cable consists of glass fibers with a common diameter in the range of 50 to 100 microns for the light-carrying element.

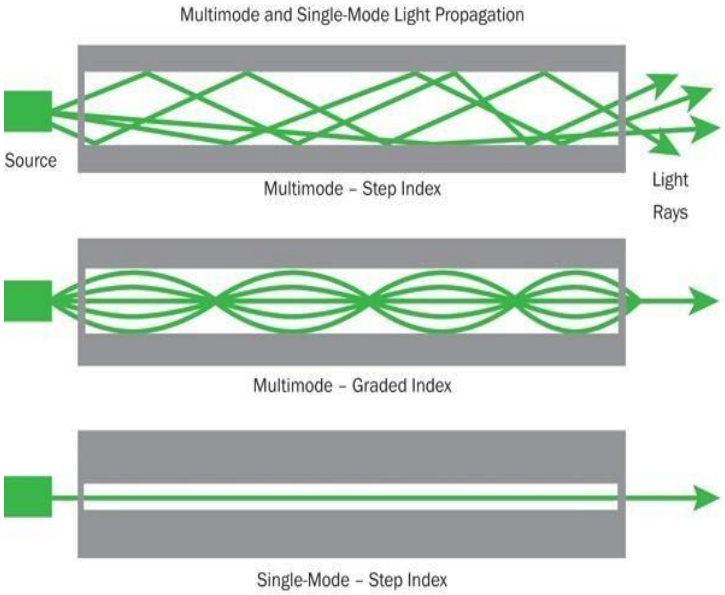

Fig.4. Types of optical fibers

TRACKING SYSTEM

In our proposed system we have attempted to make the system automatic like a “Fire and Forget” system. To carry out the experiment we have used an LDR sensor and Arduino board which is a combination of several microprocessors. Further informationregarding the Arduino board and LDR sensor are given below in the paper. But first, we need to understand how these two components are going to help us out.We are going to attach an LDR sensor in a parabolic mirror dish to identify the higher intensified sunlight. 8When the value of resistance increases the intensity of light increases and vice-versa. The value of resistance is notified by the Arduino board and it gives the command to servo motor to rotate thedish (let's say) by 20 degrees.

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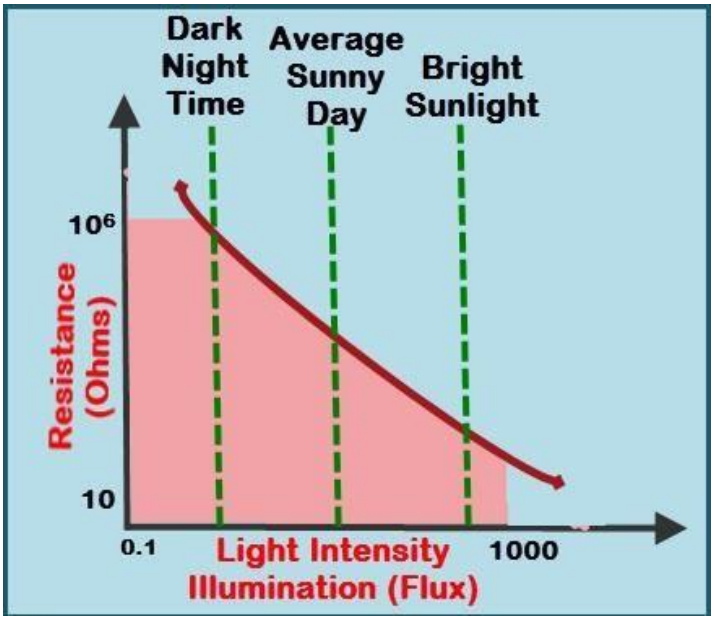

Fig.5 Working of LDR sensor

As we all know earth rotates 360 degrees around the sun resulting in day and night. So with the help of that Principle, we can rotate our device automatically. So, now command has been sent to the motor and the motor is rotating the dish according to the Arduino board. And of course, we are going to need a system that gives power to these components. So, to resolve this we have used the small battery which will run all these components. A graph has been shown (fig.5) between resistance and light intensity to show the working of the LDR sensor.

ARDUINO BOARD AND LDR SENSOR

Arduino is an open-source electronics platform based on easy- to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, and turn it into an output - activating a motor, turning on LED, etc. Arduino board designs use a variety of microprocessors and controllers. Theboards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal SerialBus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmedusing C and C++ programming languages. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

A Light Dependent Resistor (LDR)is also called a photo resistor or a cadmium Sulphide (CDS) cell. It is also called a photoconductor. It isbasically a photocell that works on the principle of photoconductivity. The passive component is basically aresistor whose resistance value decreases when the intensity of light decreases.

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Fig.6. Arduino Board

Fig.7. LDR sensor

LIGHT DISTRIBUTION SYSTEM:

As the final component in the daylighting system, distribution of light plays an important role to get an efficient result. Its main objective is to provide uniform lighting across a room without the effect of glare. It requires extraction and emission of light. The extractors can be at the endof the fibers, at multiple points, or ina continuous manner. The main function of emitter is to distribute andspread the light uniformly. There aretwo main types of extractors that work on the principle of total internal reflection are light pipes and optical fibers. As we have used optical fibersso we are going to discuss about optical fibers as an extracting device.Non-concentrating systems are morelikely to provide a uniformly distributed luminance. Meanwhile, concentrating systems require a proper de-concentrating process to achieve a similar result; otherwise, a narrow light beam will be obtained resulting in separate light batches using the average distance-to-height ratio. To resolve it we can emit daylight in a glass tube or glass bulb where the distribution can be carriedout. To improve the efficiency of daylight we can use inert gases like Argon, neon, etc. which will help us to elevate the luminance ofdaylighting system.

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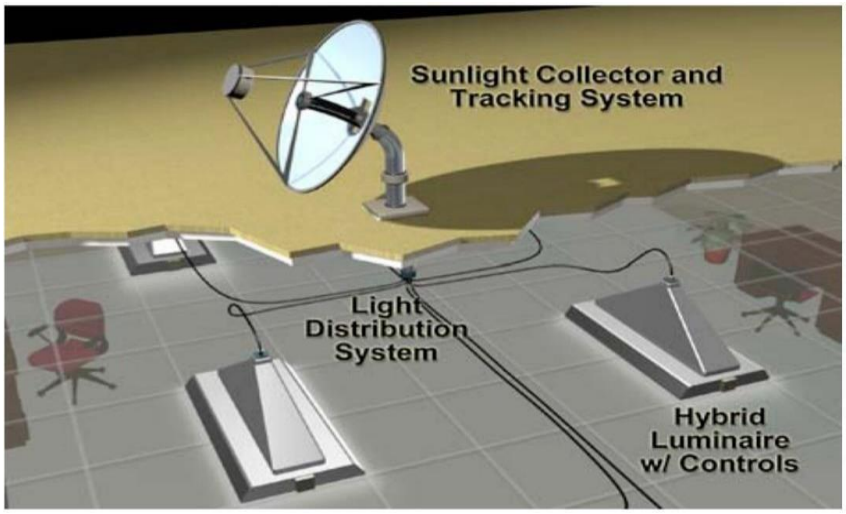

Fig. 8 Light Distribution System

CONCLUSION:

"The best way to predict the future isto design it". Energy conservation has always been an issue for India and other parts of the world. Efficientusage of energy has become the biggest issue nowadays. Non- renewable sources of energy are ending day by day. Fossil fuels and other sources are consumed at a veryhigh rate. To resolve this problem wehave to shift ourselves towards renewable sources of energy like solar energy. Daylighting system is the one of significant applications of solar energy. Daylighting system is the best way of using the sunlight instead of converting it into an electric light. While executing thisIdea we had to deal with the light intensity problem and movement of the earth with respect to the sun. Nowto resolve this issue we applied someelectrical and mechanical equipment like microprocessors and servo motors to track the higher intensified sunlight. Distributing a light througha narrow beam of fibers can be atricky thing so to get enough light inside the room proper distributor hasbeen used like glass tubes and glass bulb with inert gases.

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