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Developing a Mechanical Television

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Abstract

The invention by Paul Nipkow in 1884 consisting of a disk with holes spiraling into its centre shaped the development of television. John Logie Baird used Nipkow's disk to demonstrate the first Mechanical Television in 1926. The entire system was based on mechanical scanning of the objects and reproducing the images. Though mechanical television became outdated within fifteen years, it paved the way for development of modern television.

The working principle of a mechanical television is presented in an interactive exhibit 'Mechanical TV: How it Works' in the 'Television' gallery of Birla Industrial & Technological Museum. Keeping in mind the interactivity and operation of the exhibit by the visitors in a science museum setting, a simple and customized approach was adopted in developing the exhibit. The technique of scanning the object was thus done in a different way compared to that used in earlier Mechanical TVs. Here a parallel beam of light from a tailor-made object is first scanned by a Nipkow's disc. It is then collimated by a convex lens with large aperture. The beam is focused on a sensor, where it is picked up, amplified and fed to an electronic circuit. Instead of using a lamp as before a high glow LED is used for reproducing the image on a fluorescent screen.

Introduction

Development of television is considered to be one of the most striking achievements in the 20th century. We can not think of contemporary world without the existence of television. It's a window on the world that breaks down the barrier between nations and brings the world right into our living room. Few other media have had as much impact on us as television.

In 1926 John Logie Baird demonstrated the first television in London[1-3]. A series of inventions over a period of 50 years paved the way for its development. One such invention was done in 1884 by a German scientist, Paul Nipkow[1-5]. He invented a mechanical scanning disc, later came to be known as Nipkow's disc. The disc had perforations in the form of a spiral as shown in fig.1. When the disc rotates it scans the object in small strips, the number of strips is equal to the number of holes on the disc. At any moment a small portion of the object corresponding to the spot size of the light beam is scanned, and as the disc continues to rotate successive lines are traced out until the whole object is sequentially[5, 6] scanned. The scanning light beam bounces from the object and incidents on a photo cell where the signal is picked up for reproduction. Nipkow was unable to construct a satisfactory reproduction system because the signal was too weak to be converted back into light[1]. However, his contribution in designing the scanning disc had revolutionized the idea of mechanical television.

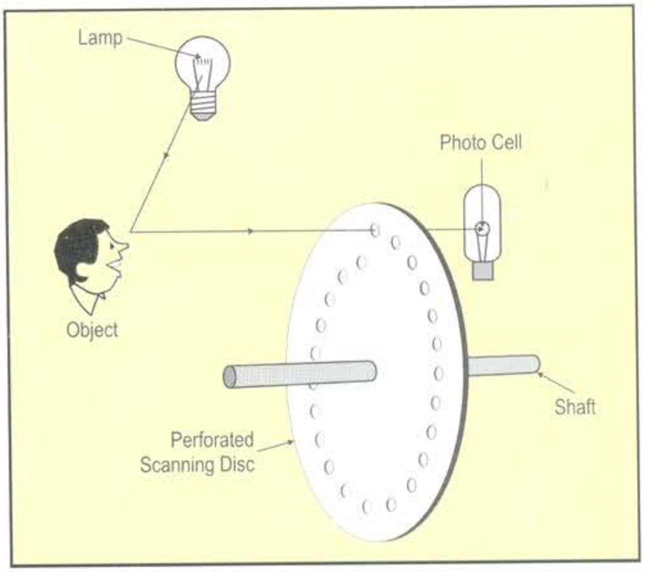

Fig. 1. The scanning Nipow's Disc.

In England, John Logie Baird devised a mechanical scanning system similar to Nipkow. However, he used valves to amplify the signal produced by a photoelectric cell. The signal lighted up a small neon lamp, in front of which a second scanning disc was set to rotate for reproduction. In 1926 Baird was able to transmit a silhouette[2] (fig.2.) and demonstrate his mechanical television.

Fig. 2. Photograph of a human face produced by first Baird's Television in 1926.

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Age of Mechanical Television

Following the success of Baird many people started working on television with renewed interest. Efforts were made in improving the mechanical scanning system and transmitting the image through air. Charles Jenkins in the United States founded Jenkins Television Corporation[3] in 1928. In the same year, using mechanical scanning system, the first regular experimental television broadcast[3] were made by the station WGY in New York. Soon British Broadcasting System (B.B.C.) adopted Baird's system as the foundation for a series of experimental broadcasts[3, 7]. Demonstration of such a television setup in operation is shown in the fig. 3.

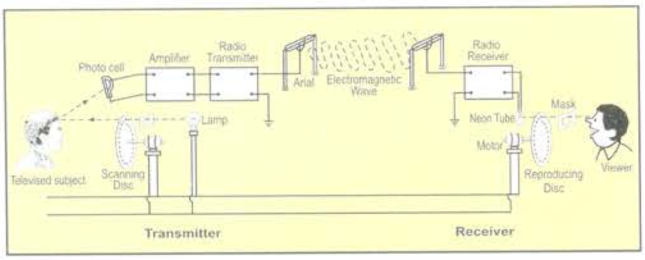

Fig. 3. Baird's Mechanical Television System.

Though image quality of 30-line transmissions steadily improved with technical advances[8, 9], image resolution remained relatively low, ranging from about 30 to 120 lines or so. This is because only a limited number of holes could be made in the rotating disks, and disks beyond a certain diameter became impractical. In 1931 Radio Corporation of America (R.C.A.) introduced a receiver[3] with kinescope tube developed by Zworkin. By 1935 R.C.A. developed a completely electronic television system. The world's first regular broadcasts of television programmes were begun by B.B.C. in London in 1936 using both mechanical and electronic scanning systems[1]. Instead of a Nipkow disk, several other technologies were also used in mechanical television. Other arrangements often made use of a rotating drum with holes or a series of mirrors fitted on it. However, images produced by mechanical scanning systems still remained unsatisfactory. The last mechanical television broadcasts ended in 1939. Mechanical systems were in use from 1928 to 1939, overlapping the all-electronic era by three years[7].

Design Challenges

Science museums and centres are the places of learning through exhibits and educational activities. In Birla Industrial & Technological Museum, most of the exhibits are participatory in nature. In such an exploration centre, visitors themselves operate the exhibits by pressing the buttons, rotating the handles or participating in other ways. For demonstration of the working principle of a mechanical television in such a setting, particularly its demonstration in the 'Television' gallery, an inventive approach was needed in designing the exhibit. First of all the entire system of the mechanical television - especially the scanning and reproduction discs - should be kept in an illuminated or semi-illuminated area in contrary to Baird's mechanical scanning to facilitate the visitors to see and correlate the scanning and reproduction processes. In such a situation light detecting sensor produces continuous signal in addition to the signals produced by the Nipkow's disc and forms a background optical noise. To overcome the difficulties it was necessary to design a suitable scanning system and that was achieved by modifying the conventional method of scanning the object. The object was tailor-made and instead of reflected light, light passing through the object is allowed to scanning. Prior to reaching the sensor it is collimated by a convex lens so that a single light sensor could pick up the signals. This makes the exhibit not only simple in fabrication but also reduces the use of multiple sensors. Secondly, as the exhibit is to be operated by the visitors themselves, the operation was also made simple. Two options were given to interact with the exhibit, one being switching on the exhibit by pressing a push button switch, and the other one is controlling the light that is incident on the object. When incident light is totally blocked casting of image on the screen disappears. For comparison and to portray the classic experiment a model of Baird's Mechanical TV is put beside this exhibit.

Development of the Exhibit

The most important part of the exhibit is a pair of identical Nipkow's disc, one for scanning the object and the other for reproducing the image. We used 6 mm thick aluminium plate for making the discs. The disc diameter is 45 cm and 14 drill holes were made on it in the form of a spiral. The diameter of each hole was maintained at 9 mm. While experimentation, diameter of the holes was varied up to 15 mm but it resulted in lesser number of holes on the disc. Due to practical constraints in the experimental set up, the disc diameter could not be increased further. It means the object is now scanned with lesser number of lines and enhanced illumination, but at the same time it leads to poor image resolution. On the other hand, experimentation was carried out with 6 mm hole size and with increased number of holes, but better results were found at an optimum size of about 9 mm.

Choice of object was interesting in the process of this exhibit development. As discussed earlier, light should pass through the object before reaching the scanning disc. A letter 'H' was cut on a metal sheet, the outline of which formed the desired object. Parallel light from a source is allowed to pass through 'H' as shown in the schematic diagram (fig. 4.).

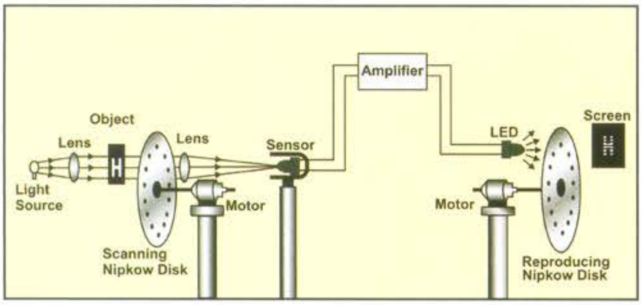

Fig. 4. Schematic diagram of the Mechanical TV developed at BITM.

It is scanned by the scanning Nipkow's disc and passed through a convex lens with aperture 15 cm and focal length 30 cm. The lens converges the scanning beams and a light sensing diode picks them up as signals. The signals are amplified by electronic means and fed to a high glow light emitting diode (LED) placed in front of the reproducing disc. The intensity of LED varies as per the strength of signals it receives from the sensor. Both the discs rotate in unison. While fixing the discs on the shaft care should be taken to avoid any phase lag between the discs. In short, there should be one to one correspondence in respect of positions of the holes in the two discs. A fluorescent screen is placed behind the reproducing disc. When the exhibit is operated image of the letter 'H' is produced on the screen as shown in fig. 5.

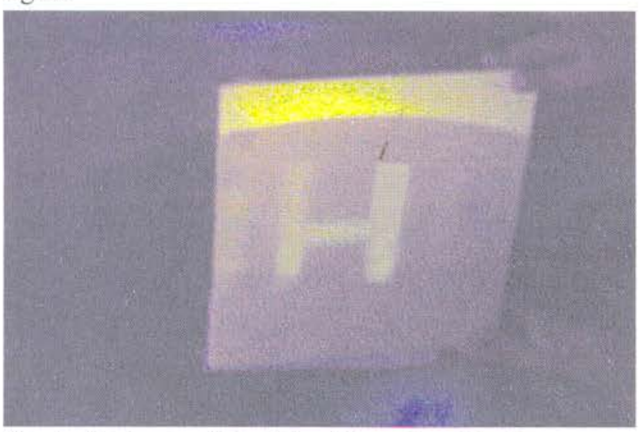

Fig. 5. The image of the letter 'H' produced by the Mechanical TV at BITM.

During experimental phase both the wheels were mounted on a single shaft. But for the television gallery, considering its ambience and display, separate shafts were used (fig. 6.) in making the final exhibit. To avoid any phase lag they were coupled through chain-sprocket

Fig. 6. A visitor is exploring the Mechanical TV in the Television Gallery.

system. The drive was given from a single DC motor and the discs are made to rotate at 400 r.p.m. To facilitate obstructing the incident light on the object a shutter was provided. Visitors can rotate a handle to block partially or fully the incident light. When a portion of the object is illuminated image on the screen is created accordingly. This helps the visitors apply their thought process to comprehend the working principle of a mechanical television, a television that paved the way in making a window on the contemporary world.

Conclusion

Some of the inventions that greatly influenced the society and brought a dramatic change in enhancing the quality of life, television is one of them. It is necessary to portray its genesis; the mechanical television to the people. For demonstrating its working principle in a science museum an interactive exhibit can be made with some modification, particularly in the scanning system. The disc diameter can be made even larger with incorporation of more scanning lines, but keeping the hole diameter optimum. However, from maintenance point of view it is better to use a single shaft for both the discs.

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