Fracarro, from the Disk of Nipkow to the Digital Convergence

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Historical introduction

The dream of transmitting images, in addition to sounds, has been considered and studied since the distant 1880, and the best results were obtained in 1884 by a disk with a spiral pattern of holes punched through it. This was invented by a German physicist of Russian origins, Paul Gottlieb Nipkow, on 24th December 1883.

When this disk, equipped with lenses in each hole, was spun rapidly, it decomposed the image into lines, starting from the most external hole (which read the upper line) to the most internal one, which identified the lower line. Therefore, the image was transformed into a series of luminous impulses that, striking a battery of photocells, turned themselves into electrical impulses: the principle of mechanical television was created.

Nipkow, only having just turned 23, considered the satisfying results of his invention and was able to patented it, but, because of the huge practical difficulties and, above all, because of the lack of a suitable method to amplify the weak signals after a few years of alternating events, he let his patents expire and almost never spoke about television again. Almost half a century passed before, on the other side of the English Channel, somebody started to reconsider that idea.

Out of both passion and curiosity, the Scotsman, John Logie Baird, in his workshop in Hastings, resumed the idea of the Nipkow disk and tried to developed it. At that time, the radio was very popular, so Baird decided to name the invention "Radiovision", which means the transmission of images via radio.

A serene and optimistic man, Baird moved to London, where he immediately published a notice in the Times in search of a financier. The advertisement was read by a cinema producer, Will Day, who can be entitled the first sponsor in the history of TV. Thanks to Day's money, Baird created the first television in a basement located in the rough neighbourhood of Soho. At the base of the apparatus, there was the Nipkow disk with a spiral pattern of holes punched through it and, after the first experiments in 1923, the Scottish scientist was ready to patent and present his discovery to the Royal Institution in London.

The essential component to make the invention work well was the presence of a photoelectrical cell that had a sensibility similar to the retina of the human eye; thanks to the photoelectrical effect, the photocell created a transduction of luminous intensity variations in the electrical signal modulations.

This photocell, located in the motion-picture camera invented by Nipkow, recorded the luminosity point by point of the object's various parts, reproducing each point with the correct intensity through a disk equipped with a spiral pattern of small holes located between the object and the cell. As the disk spun, thanks to the spiral pattern of the holes, only one point at a time was exposed to the photocell; that way, at the end of each complete revolution, all of the object's points were detected. The luminous signals were turned into electrical impulses and the receiving apparatus turned these impulses back into luminous flows (for example, by means of a neon lamp) and, that way, the process was closed. By using a second disk identical to the first, and as this disk was spinning in synchrony with the disk of the transmitting station, the eye could unite all of the points together and finally reproduce the object. Given that, after each complete revolution of the two disks, the complete formation of the transmitted image was obtained, by rotating the two disks in perfect synchrony at the speed of 12 revolutions per second, a series of 12 complete images per second was obtained on the receiving screen.

As it is known, the human eye is able to see an image, even after it does not hit it any longer for about a twelfth of a second. Therefore, it was sufficient to give the disk a speed no less than twelve

revolutions per second to allow a person, who was looking at the screen in front of the receiving disk, to see the image like it was shown continuously. To improve the effect with moving characters, the two disks (shooting and reception) were spinning at no less than 16 revolutions per second.

In 1927, the English BBC adopted Baird's "Radiovision" definitely and even prepared the first television station able to transmit up to 20 km away, which meant covering the whole city of London.

On 30th September 1929, Baird cast the first official TV transmission in the world. But the scientific progress wasn't stopped: Baird had not considered another system that consisted of using Braun's cathode ray tube, invented, made and presented already in 1897. The Braun's tube was able to emit rays by which the images could be explored and then able to be transmitted, therefore taking the place of the Nipkow disk.

Therefore, in the first years of its history, the tele-vision recorded the parallel development of two technologies: the first one based on electromechanical devices and the second one based on completely electronic devices.

Both technologies, at the moment of shooting scenes, based themselves on the properties of selenium and other materials to change their conductivity when they were hit by a luminous signal. This property was discovered in 1872 by telegraphists Willoughby Smith and J. May.

Starting from the end of the nineteenth century, dozens of scientists tried to exploit this property to transmit and receive images, but, only after First World War, thanks to the diffusion of thermionic tubes, we could see the birth of the first functioning prototypes based on two principles: mechanical scanning and electronic scanning.

From the beginning of the 1920's up to Second World War, both these two systems were used up until the electronic technique showed its superiority and was universally adopted.

In fact, exactly in the same year when Baird inaugurated the first transmission in London, a Russian colleague of him, emigrated to the USA after the Bolshevik revolution, physicist Wladimir Zworykin, created the first completely electronic system of television shooting based on the "iconoscope" and the "kinescope" from which the present television was developed. If Baird had attracted the enthusiasm of the English BBC, Zworykin attracted the attention of the president of the American RCA, David Sarnoff, who, in a short time, created a television station and cast the first transmission of modern television in 1931 with an important sports event: the boxing match of the "Ampling Alp" Primo Carnera.

Once again, the technological progress did not stop: Zworykin, encouraged by his positive experiences with the cathode tube, had already patented a colour system in 1925.

Meantime, even Baird, continuing with the Nipkow disk technology, had made a few attempts by inventing the system to use not only one but three disks whose holes were covered by three coloured filters - red, green and blue (the primary colours) - inserted both in the motion-picture camera and in the receiver.

Again, Baird obtained a few good results in 1936, when a German company - Fernseh - in the occasion of the Berlin Olympiads, cast a few clips daily.

Even if Baird partly used the mechanical disk and partly the electronics, the images were quite poor with a definition of only 180 lines. In 1939, despite the important improvements, he reached only 240 lines. By now, the mechanical television was setting down and had to give way to the electronic television era. Zworykin, in America at RCA, continued along the path of the electronic tube and, in 1939, he had already achieved 441 lines. In 1940, at the World Exhibition of New York, he cast with a definition of 525 lines and a rate of 30 images per second.

It was the beginning of modern television.

In the same year, 1940, the inventor Peter Carl Goldmark (1906-1977), on behalf of CBS, presented his electronic colour system, but always using three disks placed both in the camera and in the receiver.

The system was later overcome by the genial David Sarnoff, who made three rays generate from three different cathode tubes that, during the shooting, behaved like three different electronic brushes, each of them with one of the primary colours.
The same rays received by the kinescope and properly redirected, each one with a different angle, hit phosphorescent points able to re-emit one of the three primary colours that, recombining themselves, reproduced an image of the object on the screen identical to the original one. In 1949, in the USA, this type of colour television with 525 lines of definition became a reality.
Even the other countries did not stay there to look: in a few years, each one of them created their own electronic television. Later, there were only improvements and perfections and a larger and larger use of the transistor and integrated circuits for arriving at the modern digital age.

The mechanical television.
The first regular television service (based on Baird's mechanic technique or, like the Germans loved to remember, on Nipkow's) was inaugurated in Germany in the spring of 1935, while, in England, the service was inaugurated on 2nd November 1936 with the mixed Baird/EMI-Marconi (electronic one) system on dedicated VHF (short waves) frequencies and in alternating evenings. The first company transmitted with a completely mechanical system of 240 lines while the second one (that since February was the only one working after a decision of the PT committee) transmitted with an electronic system of 405 lines. The number of television receivers in England went from 1000 in 1936 to 23000 in 1940. In the wake of the Baird's experiments and news coming from England and Germany, even the technicians and scientists in Italy who worked in the sector of the radio-telephonic transmissions started shyly their first experiments in the television field.
In 1929 in Milan, the engineer Alessandro Banfi, after years of experimentation, was entitled by the EIAR (Ente Italiano Audizioni Radiofoniche) to develop the first device for shooting, transmission and reception based on the mechanical technique with an experimental purpose.
Even the radiotechnical industries started to devote resources and personnel to the television.
SAFAR, one of the most important companies manufacturing radio-receivers in Italy, started a series of important experiments run by the Engineer Arturo Castellani. The results were exhibited in the second National Exhibition of Radio in 1930 in Milan where practical television experiences were also proposed to the audience.
But it was the company of the brothers Giovanni and Bruno Fraccaro in Castelfranco Veneto that, in the early 1930's, put in production and traded the first televisions (or its components in an assembly box) based on a mechanical reception system with the Nipkow disk, with the slogan "La televisione per tutti" (The television for everyone) devoted to enthusiastic people and radio amateurs. That way, they contributed to the mass diffusion of the new apparatus.
The two brothers proposed an assembly kit with which one could build his or her own mechanical television by using fan motors and radio tubes. The two enterprising radio amateurs made available to the public, for sale, the neon lamp (or Kerr's cell) and the Nipkow disk in aluminium and a very clear brochure titled "La televisione per tutti" (see Fig. 1) that had to be followed step by step during assembly so that it was possible to build the mechanical television and receive the television signal from London and Berlin.
The purpose of the brochure was to very clearly present the principle that radio-television was based on, and, above all, to allow every radio amateur to easily and cheaply build the simplest apparatus that allows one to see what was transmitted from the distant studios of the radio stations that diffused the television signal.
In particular, the 1930 brochure says that "*the London station transmitted almost every day, but, during the light hours, when the reception intensity was generally insufficient in Italy. It transmitted in the evening on Tuesday and Friday at the end of the radio-telephonic program and these transmissions could be regularly and perfectly received by a Nipkow disk with 30 holes, vertical scanning, vertical side of the board with dimensions two times bigger than the horizontal one and the speed of the disk of 12 and a half revolutions per second.*

And again, it says that *the Berlin station transmitted daily, but, during the light hours, when the reception intensity was generally insufficient in Italy. But it experimentally transmitted the "Film" every Friday night after the radio-telephonic program, and this transmission could be regularly and perfectly received by a Nipkow disk with 30 holes, horizontal scanning, vertical side of the board with dimensions three quarts of the horizontal one and with the disk speed of 12 and a half revolutions per second* (to receive from Berlin, it was necessary to make a new disk and, in the brochure, there are the detailed instructions to build it).
Moreover, the brochure explained in detail, for example, how it was possible to maintain a receiving disk in a proper synchronism with the transmitting disk; there were essential characteristics to make the television (such as the neon lamp, the electrical motor, the Nipkow disk, etc.); the tests to be carried out to perfect the system; the possible changes to improve the quality of the television if the buyer wanted to pay a great deal more; the possible corrections to be adopted to increase the quality of the received images and lots more.

From the mechanical television to the modern television
This year, the National Museum of Sciences and Technology Leonardo Da Vinci in Milano, with the aim to show the evolution of technology for the production, transmission and reception of television images, from the first mechanical experimentations to modern digital technologies and understanding the social evolution of this apparatus (uses, active subjects and protagonists) by pointing out the digitalization process, has prepared an area titled "Dalla televisione meccanica a quella digitale" (From the mechanical television to modern television), which was exclusively devoted to Fracarro and the story of TV, radio and telephonic communication: the exhibition presents two specimens of televisions based on the synthesis (reception) technique with the Nipkow disk.
The first specimen was produced in England, thanks to the genial John Logie Baird. This apparatus, made between 1930 and 1932 by the Plessey Company, was the first television ever manufactured industrially and devoted to a mass public. Almost 1,000 units were built and sold all over Europe in the early 1930's. The enthusiastic and wealthy public had to be content with the low quality of images and a still experimental service that was irradiated on the frequencies of the medium waves by the BBC.
The second specimen (see Fig. 2) is a very rare prototype made by the brothers Giovanni and Bruno Fraccaro, equipped with a series of 10 Nipkow disks and the famous script made by the two enthusiastic radio amateurs, about whom we have talked.
The museum room also contains the reconstruction of the two devices (shooting and reception) for a mechanical television system with a Nipkow disk that worked according to the analysis and synthesis principles used by the inventors Baird and Fraccaro.
The connection between the two devices (separate of a few meters) occurs by a low power radio link. The interactive specimens can perform the following operations on moving images:

- Shooting/analysis of the moving images;
- Transmission of the moving images via radio;
- Reception/synthesis on the moving images on a mechanical television.

In that pioneer period, a few important programs were made, above all, by the BBC and Baird in England. In particular, the wonderful and very rare work by Pirandello "L'uomo dal fiore in bocca" cast by BBC in 1929, in collaboration with Baird, will be shown to the visitors.

The wing of the museum devoted to Fracarro covers all the history of the television, from the Nipkow disk to the digital terrestrial technology up to arrive at the digital convergence. That is where Fracarro is going to create "intelligent" buildings where new services will be available for the users to make their lives easier as well as to manage the house easily.

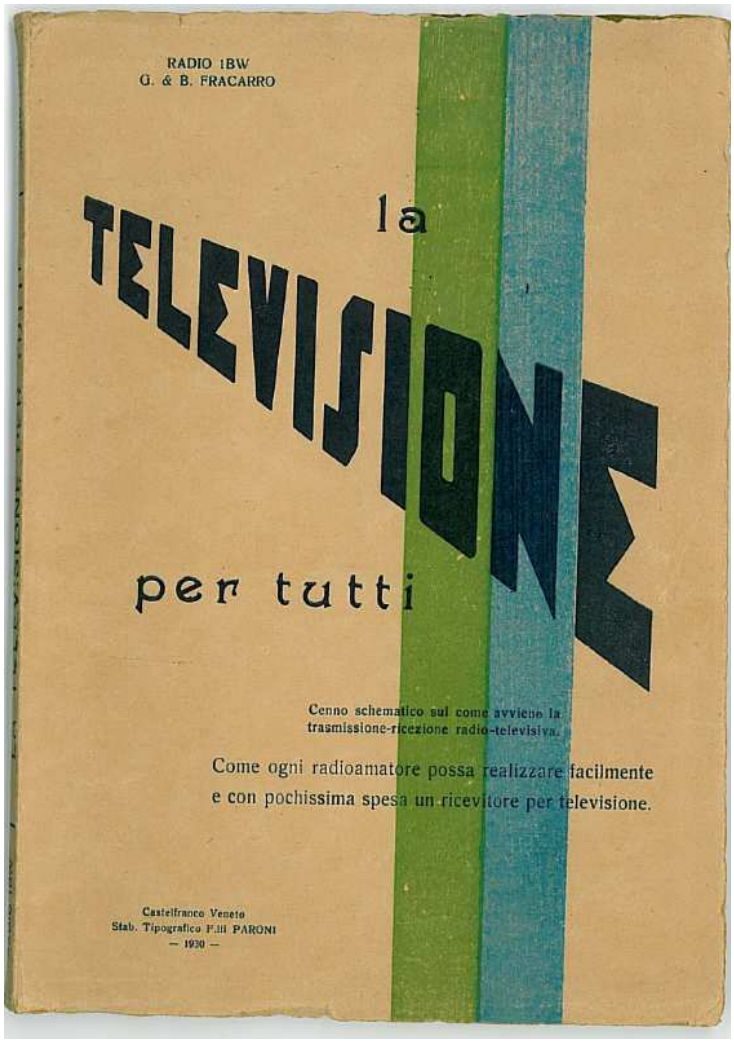

Fig. 1. The 1930 brochure “La televisione per tutti” wrote by Giovanni and Bruno Fraccaro.

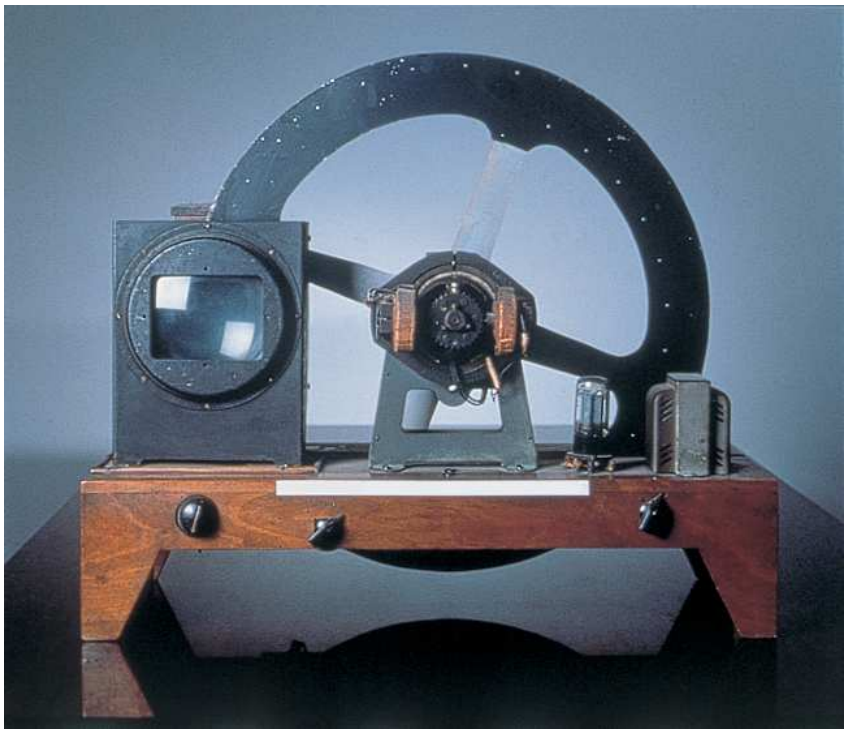

Fig. 2. Prototype of mechanical television made by the brothers Giovanni and Bruno Fraccaro.

The convergence of technologies

In the '90's, the last bulwark of analogue transmission fell and the digital television was born. One of the first consequences caused by this technological jump was the possibility to connect and let different systems communicate with one another. This possibility is called Convergence. The television of the future goes beyond the traditional concept of passive use and becomes an interface through which the multimedial contents coming from traditional broadcasters, as well as Internet and home hard disks, can be used.

In the same way, in the sector of the safety, we can think of managing the intrusion - detection systems directly by one's mobile phone and seeing TVCC images through TVCC on the home television. That way, the television is an obvious means to be used for the management of all systems related to the domestic comfort that now is defined as home automation.

In fact, convergence is applied to all the applications of the reception and distribution of Audio, Video and Data signals, as well as in the telephony communication, the security sector and home automation. By the means of the home television set, one can have the opportunity to access services supplied by the Public Administration, e-learning banking and medical.

In fact, the television braodcasting, with all their different forms, such as analogue, satellite, terrestrial digital, and cable, is commonly available in the house of any person where several contents and interactive channels are differently used by the public, even to obtain useful information- as well as – to be informed directly from their home TV about banks, hospitals and shops.

This means that, as the birth of the mechanic TV changed the history of communication, the digital convergence is similarly opening a new era where it is no longer an illusion to speak about "intelligent" buildings that allow a different way to communicate and use services.

Now it is possible to watch TV on the beach through the mobile phone as well as to use the television structure of the building to distribute LAN services by avoiding further wiring interventions that, in some areas, are difficult to realize. Moreover, it is true that the challenges of the AVD signal distribution continue to open new sceneries that presume new application models able to improve the life and the comfort of each user.

Fracarro is dedicated to follow this pathway, already trading distribution systems of the video audio signal through the LAN networks, both traditionally and through plastic fibre optics and wireless.

The evolution does not limit itself to the building, but also extends itself to the machine communication through multimedial interfaces that include vocal recognition, advanced systems of interactive graphic that facilitate on integrated management of all the entertainment and home automation services.

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