Current Journal of Applied Science and Technology

40(16): 68-81, 2021; Article no.CJAST.70034
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

History of Plasma Display Reflected by Patents

Octavian Baltag[1*]

[1]Grigore T. Popa Univ. of Medicine and Pharmacy, Department of Biomedical Engineering Universitatii Street, No. 16, Iasi 700115, Romania.

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/CJAST/2021/v40i1631426
Editor(s):
(1) Dr. Chien-Jen Wang, National University of Tainan, Taiwan.
Reviewers:
(1) Aditi Mishra, Rush University Medical Center, USA.
(2) Xinwei Niu, Penn State Harrisburg, USA.
(3) Noor Abdul Khaleq Zghair, University of Technology, Iraq.
Complete Peer review History: https://www.sdiarticle4.com/review-history/70034

Review Article

Received 10 May 2021
Accepted 17 July 2021
Published 21 July 2021

ABSTRACT

The paper is a historical presentation of the development of television and presents chronologically the evolution of the use of plasma in television.
The first inventors who proposed the use of plasmas together with imagined solutions and patents related to plasma display panel - PDP are presented.
The first attempt to accomplish an extra flat display by using a modified cathode tube is also presented. Yet, the technological difficulties stopped its utilization at a large scale in television. The solutions that determined the realization of certain TV displays with applications in other fields of electronics are also introduced. A pioneer invention from the 1960's, which set the bases of future TV displays, is also specified. The utilization in the 1970's was the most adequate technological solution for the realization of the first thin displays, a solution which survived even after the appearance of the LCD and LED systems.

Keywords: plasma display panel – PDP; pioneer inventions; flat screen; plasma television; television.

1. INTRODUCTION

Image representation in television was closely related to the development of television systems in itself. A television system has as "terminal" element a complex transducer, which converts the electric signal in luminous monochromatic or coloured images, transducer that is also found in the construction of electronic computer systems.

Up to 1925, the transmitted image was obtained by using electromechanic systems accompanied

**Corresponding author: E-mail: octavian.baltag@bioinginerie.ro;*

by a light source modulated in intensity by the transmitted signal, or a cathode tube that reproduced the image on a screen scanned by an electron fascicle. The first public television demonstrations and transmissions used a monochromatic image representation in grey tints. The reproduction was generally mechanical, using Nipkow disk or equivalent opto- mechanic systems – revolving mirrors. In parallel, the researchers were dealing with electronic systems for image catching and reproduction.

In the case of telegraphic transmission of images and texts, there have been numerous precursors, each of them surpassing antecedents through approached technical solutions, image quality and transmission speed. In the case of plasma TV screens, the situation is much poor in trials and technical solutions.

It is difficult to specify which was the most important stimulus in the development of an image representation device using mechanic-optic or electronic systems, but, no doubt, one can suppose that this was the quality of the transmitted image. The phenomena related to electric discharge in plasma were investigated much later; in 1928 Irving Langmuir introduced the concept of “plasma”, defined as follows [1]:

"Except near the electrodes, where there are sheaths containing very few electrons, the ionized gas contains ions and electrons in about equal numbers so that the resultant space charge is very small. We shall use the name ***plasma*** *to describe this region containing balanced charges of ions and electrons."*

Certainly, the new state of aggregation of the matter produced by electric discharges, stimulated inventors imagination to find technical applications.

What concerns plasma applications, the first ones were in optic signaling, and the first plasma representations consisted in symbols, numbers or letters as the result of the development of numeric and computing measuring techniques. Plasma was used in electronics for different applications such as: maintain a constant pressure of gas in the discharge space [2], claimed gas discharge devices which are capable of conducting large magnitude current [3], methods for decreas ing the ionization time of gas discharge devices [4], electrical pulse counting such as cold cathode type Dekatron tubes [5,6], a novel cold cathode discharge device having extremely stable breakdown and operating voltage [7].

The physical realization of broadcasted image transducers that made use of plasma appeared much later, after the years 70s’. Plasma utilization presents a series of important advantages: considerable diminution of the supply voltage and the volume, the new system becoming an extra flat device. A disadvantage can be related with the pressure difference between the gas enclosure walls, even though it is much smaller than that from the voided cathode tube. For a long period, plasma flat screen has become a strong competitor for the cathode tube systems, which it practically eliminated, but also for those with liquid crystals or LED, which it practically eliminated, but also for those with liquid crystals or LED, having to be replaced by TFT- LCD systems starting with 1990s’.

The complex processes generated in plasma (that cover practically the entire visible spectrum, together with ultraviolet and infrared ranges) have been used for the realization of devices having most diverse applications: lighting, spectroscopy and research, the most numerous being those generically named “plasma display”, with applications in digital measuring means. The special brightness and light efficiency- better than 5 lm/W – of a visible discharge element “pixel” have determined the utilization of a gases combinations to produce the plasma. Another advantage of plasma utilization is the radiation in the ultraviolet range, which, by means of the excitation of structures with phosphorus doped with different additives, generates a fluorescent radiation in different spectral bands.

The gases Ne, Ar, Hg used in well-established ratios and at low pressure of tens to hundreds mbar, are used together in mixtures which, through Penning effect, determine the diminution of the discharge voltage. In order to obtain different colours from the visible spectrum, the phosphorous structures are doped with ingredients, resulting in compositions dedicated to certain spectral bands

In 1969, is presentad at International Electron Devices Meeting a practical flat, gass discharge panel with 17,000 digital element, having 33 lines per inch. Panel thickness is ½ inch and active area is about 4x4 inch [8]. In 1971, one similar panel was presented at International Electron Devices Meeting. n this panel the ignition of the cells is obtained by the interaction of light with a photosensitive layer [9]. In paper [10] are presented the calibration and control of the gray scale. The historical evolution of plasma panels is presented in the papers [11,12,13]. The appearance and stage of color plasma television are presented in the paper [14]. The beginning of the construction of large plasma screens are shown in [15], and the stage (for the year 2012) and evolution of plasma screens are presented in a seminar [16].

2. PRECURSORS OF PLASMA TELE-VISION

Along several years, the idea (sprang from the mind of a Magyar inventor, one does not know how) of using plasma as a possible solution for the realization of a flat screen, was interknitted with innovative solutions of a flat screen which converted Braun's cathode tube by a revolutionary manner of electron beam control.

It was quite difficult to find in literature a number of precursors of plasma utilization in the reconstruction of an image starting from the received electric signals. The first citation (and the only one for more than 30 years) of the possibility to use plasma in a television system was found in a documents stacks [17] situated at "*Hungarian Academy of Sciences Manuscript Library*" including works – patents description in German and English, as well as manuscripts belonging to Kálmán (Kolomon) Tihanyi, a physicist and inventor from Hungary. One of the manuscripts, entitled "*Television apparatus with running discharge light spot"* came into notice because it refers to the description of an invention concerning a new television system that uses for both emission and reception, plasma devices to catch and reproduce images on a flat screen having practically two dimensions. The manuscript, dated in 1936, was studied and published in the magazine Hiradástechnika, 2004/1 [18] by the engineer Horvath Gyula - consultant in telecommunications. We have no information concerning the publication or filing an application for a patent registered by Tihanyi for this system.

Kálmán Tihanyi (1897 - 1947) was a Hungarian physicist and inventor [8] - electrical engineer, according to some authors - who was compared to Edison, given his creative and inventive ingenuity, with inventions applied in numerous domains. He is one of the pioneers of the electronic television, with remarkable contributions in the construction of image catcher and promoter of plasma television, having also numerous innovative contributions in the field of military technique, such as aircraft without pilot, precursor of the present drones, infrared view system, etc.

He studied at first at the University of Technology and Economy from Budapest, and then, at the Electrotechnics School from Bratislava; he studied physics and electric engineering. He improved the systems that used cathode tube, patented a television system, which he named *Radioskop*. In the technology of imagine captator tubes, Tihaniy introduced a new concept, namely "*charge accumulation"*, a concept used then by Zvorykin and *"Radio Corporation of America"*. The system named *Radioskop* was patented in Hungary, France, England and Germany, being also registered in the *"World Memory Record"* – "UNESCO".

Fig. 1. Kalman Tihanyi

What concerns the plasma television, there is very few information, most of it coming from a manuscript storehouse, and a paper [9] published in 2004, entitled *"Flat image tube, EMC compatible – anno 1936!"* that reveals another important element: plasma flat screen satisfies also the requirements related to electromagnetic compatibility. The idea of plasma utilization was entirely revolutionary, Tihanyi using plasma to both catch the image and reproduce it in TV flat screen. The author of this paper gathered information from the manuscript found in the "Archive of MTA

Manuscripts”. One must specify that the document can only be used with the permission of the copyright inheritor.

The description from the manuscript only refers to catching, transmission and reproduction of the image, not of the sound, considering that the existing solutions are covering. The photosensitive element is coated with sulphur telluride or thallium sulphide, etc. The operation of electric charge accumulation during the exposure of image element is similar to the process from the iconoscope condenser matrix. Both the optic image collector and image reproduction contain a discharge tube filled with high-pressure gas that covers the entire surface, following an imaginary scanning line. The inventor realizes that the electric discharge in plasma generates electromagnetic disturbances in the environment, being able to affect the operation of its own electronic structures or from the vicinity, and can also disturb the viewers. Accordingly, he proposes to place the discharge tube, image generator inside of a metallic case for shielding, thus satisfying the present requirements related to electromagnetic compatibility.

Tihanyi suggests, as a solution for the construction of the device for image catching and its conversion in electric signals, the utilization of an electric field traveling with a high speed along the exploration lines, consisting in a series of miniature electrodes deposed on a glass plate. It seems that the electrodes represent a transmission - exploration line, through which an electric discharge is moving, whose purpose is to address an image element; by discharging the accumulated electric charge, one transmits a signal corresponding to the image element. The flat screen receiver reproduces the image by modulating the impulses sent by the transmitter, such that the image can be reproduced either through the luminous spot generated by the discharge itself, or by the excitation of a phosphorescent screen filled with a high pressure inert gas.

The idea of plasma television as presented here seems closer to a research hypothesis, than a technical solution realizable according to the manuscript concept. It is regrettable that it was neither materialized nor developed by other inventors. The most probable is that this proposal was not known, as it was not published, and one does not know other preoccupation related to this idea, seemingly arrived much too early as opposed to the scientific and technologic level of that time. It is possible that the war events, and Kálmán Tihanyi’s participation in the Resistance Motion had deteriorated his health, and his unexpected death in 1947 due to a heart attack hindered the materialization of the thoughts written by the author in his manuscript.

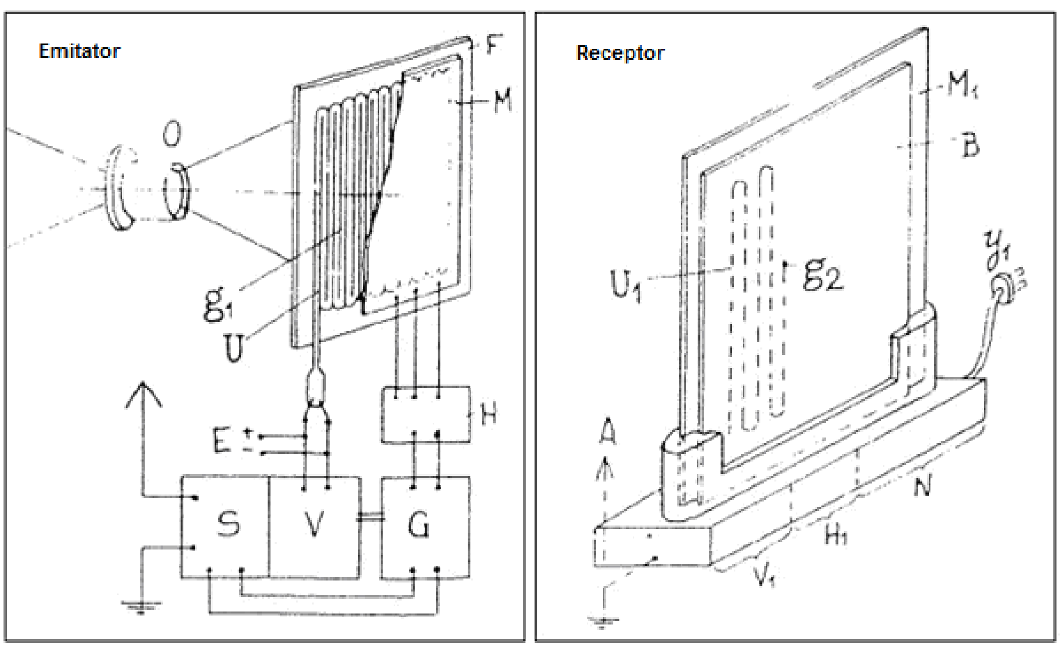

Fig. 2. Kálmán Tihanyi’s idea of plasma television

Like in other cases (image transmission through telegraphic systems), one can rediscover, among the precursors of a system, solutions that use principles and phenomena different from the final ones; yet, taking into account the stage of science at those moments, they can be considered as precursors. This is also the case of plasma television. It is difficult to understand the lack of preoccupations concerning plasma applications in television for such a long time. Yet, the situation was the same in the case of Nipkow disk, which expected 40 years until its utilization by Baird. It is also possible that the very quick development of the television, culminating with color television has captivated the attention of researchers in this field.

One can suppose that the volume of the cathode tubes used both in radar stations and in television represented an important reasoning to find innovative technical solutions, which permit the realization of flat screens. The transition from image transducers with electronic tubes to ionic transducers – with plasma - was carried out after passing to a stage when the researches have been directed to the realization of flat screens, which initially used also electron beams.

3. PRECURSORS OF FLAT SCREEN

A first proposal concerning the realization of flat screen television was stated in 1954 by General Electric, the idea arising as the result of researches concerning the modernization of monitors used in radar stations. The news of a futurist screen for television was published in the magazine “Popular Mechanics” [19] from 1954.

Fig. 3. The futuristic TV set - prediction of General Electric

Results should be clearly described in a concise manner. Results for different parameters should be described under subheadings or in separate paragraph. Table or figure numbers should be mentioned in parentheses for better understanding.

The first display with production flat screen was the Aiken’s tube [20], developed at the beginning of 1950’s and it was produced in a limited number in 1958.

The flat cathode tube was invented by William Ross Aiken (19 Feb. 1919 - 26 Feb. 2007) and developed by Kaiser Aircraft and Electronics Corporation Laboratories. Douglas Aircraft Company developed this invention for applications in military aviation, in the idea of its utilization as both electronic windshield and indicator for pilotage. More objective information [21] regarding this invention appeared also in “Popular Mechanics” in 1958.

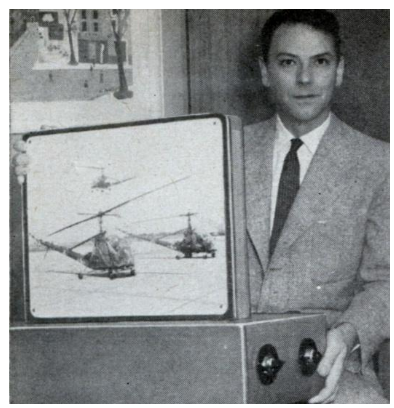

Fig. 4. William R Aiken and 21 inch TV set

Fig. 5. Used of TV flat tube in airplane cockpit

In civil applications, the tube was 2.5/8 inches thick, and its surface was equivalent to a conventional cathode tube, i.e. 21 inch. The tube was meant to be controlled by a small computer developed by Allen B. Dumont Laboratory Inc., its beneficiary being Bell Helicopter Corp. The technical solution consisted in changing the direction of electron beam such that screen scanning was performed by a double deflection. The method consisted in deviating the electron beam parallel with the phosphorous screen surface, after which it was rotated at right angle perpendicularly to beam and screen. The deviation was accomplished by means of deflection electrodes placed parallel to the screen [22].

The cooperation with Kaiser Aircraft was fruitful given the obtained results, but the production technological difficulties and perhaps those related with patenting, industrial ownership or those related to special applications have not permitted the development of this system. The excerpt from an interview with Aiken in 1966 is also significant:

”They finally agreed to a license. But, at the last minute, I guess at a Board of Directors’ Meeting for the final approval, somebody on the Board of Directors of RCA said, "Wait a minute, we’ve forgotten something. How are we going to explain to our stockholders that we wasted millions of dollars on the wrong tube?" And there was silence. And that did it. They said, "No, we will not take a license." So then we went to other tube manufacturers. There were many in those days, and none of them would touch it because they already knew, like Philco, there would be a battle with RCA. "RCA will spend millions and millions, and lose money and lose money, until they put us out of the business. So we cannot go ahead." So, nobody would take it.” [23].

The invention was also used in the realization of an oscilloscope with two spots oscilloscope [24], each one of another color: “Geer- Aiken oscilloscope”. The publications of the research and findings have been important elements in the evolution of the future flat screen TV sets and monitors. However, General Electric did not continue the necessary research and development and never built a functional flat panel at that moment.

The invention of Aiken - US patent No 2,795, 731, entitled “Cathode Ray Tube” can be considered as ”*a pioneer invention”* [25], because the first patent applied in 1953 was the main source of inspiration for the development of a series of patents concerning the long- dreamt flat display, with applications in computer and television systems [26-37]. The patent is quite thorough in its descriptions; it has 50 pages and a number of 75 drawings with details on the structure of this new cathode tube destined to image representation. The patent comprises a number of 147 claims regarding both the structure and the method by whose means one can provide screen scanning by the electron beam.

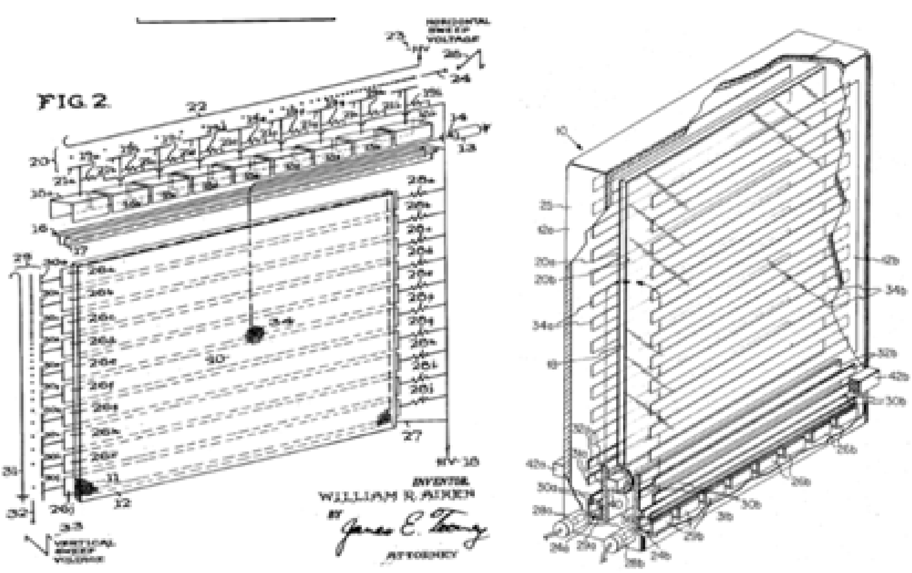

Fig. 6. Invention of Aiken - “Cathode Ray Tube” - a pioneer invention

"Figure is a schematic exploded perspective view of a monochrome cathode ray tube and associated components embodying certain features of the present invention, wherein the electron source is arranged to provide an electron beam in substantially parallel proximity with the viewing screen, wherein the horizontal sweep deflection system comprises a plurality of electrostatic deflection plates, the deflection control voltage to each of which is provided from a lineally arranged triode control tube comprising a variably spaced control grid, and wherein the vertical sweep deflection system comprises a plurality of electrostatic elongated plates arranged in a plane sub spatially parallel and slightly spaced from the viewing screen, the control voltages for said plurality of vertical sweep deflection plates being provided from a lineally arranged triode control tube comprising a variably spaced control grid."

The need of large advertising panels was an important incentive for the replacement of electric bulbs used for static images with gas discharge lamps, with which one can obtain moving images, having a much shorter response time. Still another advantage was to use for control semiconductor electronics, i.e. transistors and thyristors.

4. PRECURSORS OF PLASMA DISPLAY

In 1964 an application is filed, and the US Patent 3,356,898 is taken-out, entitled "XY Glow lamp display with switch from igniting to holding voltage", for an image display panel, the light source of a pixel being a gas discharge lamp, Fig. 7, discharge control being carried out by using a transistors matrix network [38];

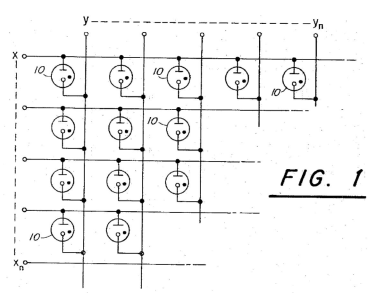

Fig. 7. XY Glow lamp display

"Neon glow lamps on a rectangular grid are selectively illuminated to show pictures. To conserve power when large numbers of lamps are on, the transistor switches for applying ignition potential, are each paralleled with a Zener diode for applying the lower glow potential."

„By arranging small lamps which can be lighted in vertical and horizontal rows, much information can be pictorially displayed on a large screen. At each cross-over point of the vertical and horizontal, or X and Y, bus bars is connected one lamp so that by appropriate energization of selected X and Y bars any one lamp or group of lamps can be lighted. It is clear that the current drain can become quite large when hundreds or thousands of lamps are used, so that voltages at lamp terminals can become marginal."

Another inventor, Steinmeyer D. J. obtains in 1967 the US Patent 3,300,581, entitled "*Flat screen electroluminescent X-Y display*" [39], Fig. 8, with a depot from 1964. The invention, thought to television screen uses an electroluminescent material subjected to the action of electric fields generated by two networks of electrodes places perpendicularly on one side and the other of the electroluminescent phosphorus film.

"Flat electroluminescent display device, for use in television receivers,, radar and sonar indicators, oscilloscopes, computer X—Y readouts and the like. When an is applied between one of the conductors 4, 4 in the top electrode 1 and one of the conductors 5, 5 in the bottom electrode 2, the phosphor surrounding their intersection will glow, or electroluminescence, producing a spot of light."

No applications in TV receivers is known; the matrix structure used to form a pixel was hard to control, taking into account the high level of the excitation voltage and the complexity of the control electronics.

In 1965, Hashimoto Ken applies for a patent for a TV display, entitled "*Flat screen television display apparatus*" [40], Fig. 9, for which he takes-out in 1968 the US Patent 3,379,831.

"Wall-television device, comprising bulb picture elements, formed by connecting diodes in series with parallel elements comprising 'bulbs and condensers. A picture screen is formed by horizontally arranging a plurality of said bulb picture elements side by side to form a horizontal picture consisting of elementary lines and by arranging a plural number of horizontal picture elements side by side."

The screen consisted of bulbs sequentially supplied through a transistor matrix network. This system is unlikely to be able to operate in a TV receiver, given the inertia of filament bulbs.

Over almost 40 years from Langmuir' work, in 1966, at Urbana Champaign University of Illinois, the professors Donald Bitzer, Gene Slowwow and the student Robert Wilson realized a digital display for a computing equipment destined to display and memorize/store the logical levels of a digital computing system. Afterwards, they also developed and licenced a complex device for memorizing and displaying on a screen the digital informations generated by a computer. This panel with monochrome display was successfully used only in computing equipments because, having the function of both memorizing and displaying some logical states, it becomes popular at the beginning on 1970 .

The patent entitled „Gaseous display and memory apparatus" [41], Fig. 10, was filled in 1966 and assigned in 1971 with the number US 3,559,190, the authors being professors Donald M. Bitzer, Hiram Gene Slottow and the student Robert H. Wilson. A brief summary of the invention is presented hereto:

"Plasma display apparatus for information storage and display having a bistable gaseous discharge cell with memory characteristics arising from charge storage on the cell walls. The panel is a matrix or array 20 of a plurality of minicells. By applying a voltage between a pair of external conductors the particular gas cell at the intersection of the corresponding conductors is discharged. For instance, the gas cell 24a is directly between and at the intersection scale; of the external conductors 30a and 32a so that when a voltage large enough to ignite a discharge is applied between these conductors which are located on opposite sides of the cell array and external to the gas itself, only the gas cell 24a at the intersection of the conductors will fire."

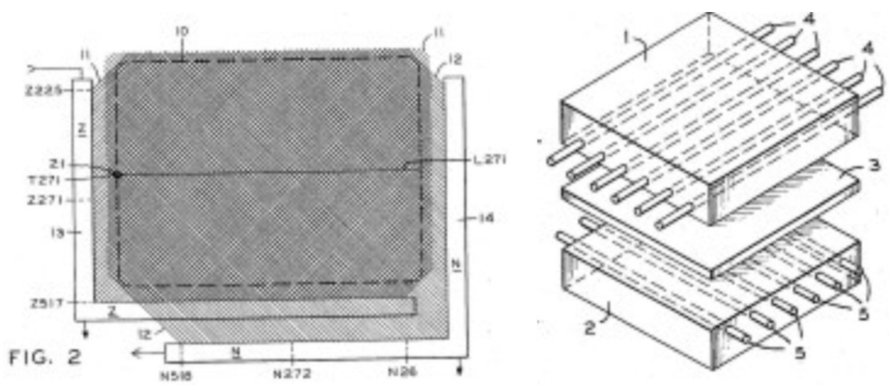

Fig. 8. US Patent 3,300,581 Electroluminiscent X-Y display

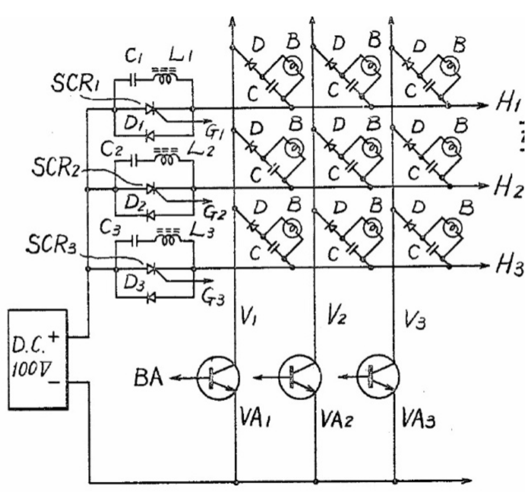

Fig. 9. US Patent 3,379,831, Flat screen television display apparatus

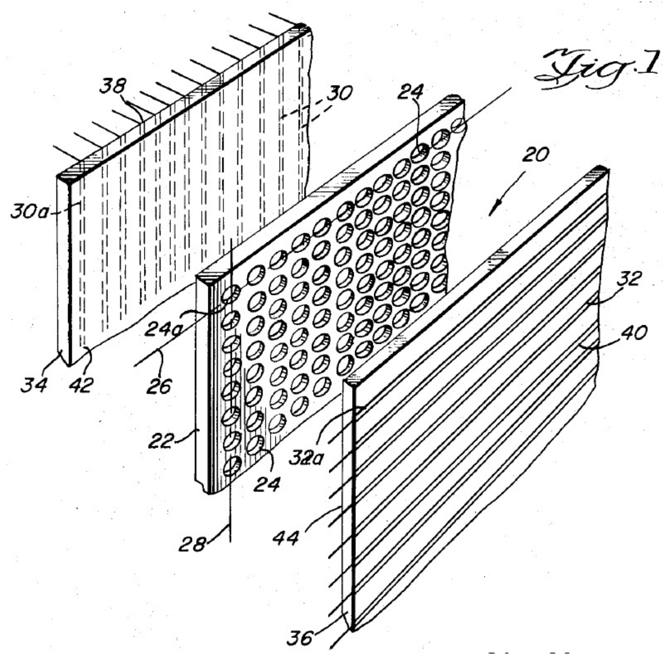

Fig. 10. Gaseous display and memory apparatus

The “Plasma Display Panel” – also known as “PDP”, permits the indication of only two logical states, such that the monochrome image, having the color determined by the used inert gas, was only used in computing technique. In 1968, Bitzer controls the cell excitation level, taking-out two patents, which permits the indication of some intermediate hues. Even if it was not used in television, this was an example of successful utilization of plasma display systems. Starting with 1970s’, some US companies develop plasma discharge screens that begin to be also used experimentally in the representation of some images, like those from television.

5. INVENTIONS OF PLASMA TV DISPLAY

In Romania of 1960s’ researches in plasma field were carried out at the level of basic studies, at the Universities of Bucharest and Iasi. The researches concerning plasma utilization in the realization of some display devices have been materialized in the realization, some years latter, at IFA Magurele, of some devices for plasma alphanumeric display for applications in computing technique and measuring equipment.

In 1967, a student of the Physics Faculty of Iasi, files at OSIM Bucharest a patent application for a ***Current- imagine transducer*** meant to be used in television to convert video signals to images.

The patent with the number RO 50108, Fig. 11, [42] assigned in the same year, describes a display with plasma and electroluminescent materials, placed in a sandwich-like structure, this being the first invention from Romania related to plasma utilization in complex devices [43] , such as television screen [44].

From the description of the invention, we quote the text referring to the drawing, Fig. 12, that presents a cross section through the flat screen structure.

- ***“Current - image transducer***

“The present invention refers to a device that converts the video-frequency signals to light images. The first devices recomposed the image by means of a Nipkow’s disk; then it was replaced by the Braun’s tube used until now, with improvements. These show some disadvantages, such as high voltage supply source necessity, image distortions, large volume which was one of the hindrance that opposed to TV receiver miniaturization. In order to reduce the dimensions, the deviation angle is increased but this entails an increase of geometric dimensions for whose diminution one uses different methods- not quite efficient. Afterwards, ion traps with electrostatic lenses or permanent magnet were used in order to reduce the ion

spot. In order to reduce the dimensions even more, one resorted to deflection angles of up to 180°; this resulted in the diminution of image definition and complicated the tube construction. The image definition is maximum in the center of the image, and it decreases to the margins. Besides the Nipkow's disk and Braun's tube, other devices were proposed, based on the piezoelectric effect and electroluminescence of certain materials, but these proposals did not give satisfactory results, as the contrast and definition were very small. In the following, we describe a device that no longer presents the above mentioned shortcomings, referring to the figure that represents a cross section with one of the sides. An electroluminescent phosphorus film 3 with the thickness of some micrometers is deposited on the grid of transparent electrodes 2; above this there is a dielectric perforated mask 4, its holes being filled with a resistive material 6. There is then a dielectric plate 7 with grooves 5; in these grooves there is an inert gas, and on groves bottom the electrodes 8 are placed. The electrodes 2 are covered for protection with a glass plate 1 welded to the plate 7. The terminals of the electrodes 2 and 8 are pulled out on two of device sides. If one applies on two of the electrodes a voltage exceeding the discharge firing voltage, a free discharge occurs in the gas from the grooves, and phosphorus becomes luminescent in the point where the two electrodes intersect, the luminescence increasing with the voltage applied on the film surface.

In order to explore the entire surface, one applies out of phase signals to the electrodes 2 and 8, such that the scanning is carried on the bias. Positive signals are applied on one of the grids, and negative signals on the other, both being modulated (to produce grey shades). The device according to invention does not need heating sources, as the classical transducers; it works at much smaller voltages, is practically bi-dimensional with a much simpler structure, does not need high vacuum installation for manufacturing, does not produce pin-cushion or barrel - type distortions, has a constant image definition on the entire screen surface and can be built at any high dimension desired.

6. CLAIMS

The current-image transducer for television set is characterized by:

1. *Grid of transparent electrodes 2, on which electroluminescent phosphorus film 3 is applied.*
2. *Perforated mask 4 and resistive material 6 introduced in the holes of the mentioned mask.*
3. *Non-linear elements consisting of cells 5 in which there are the inert gas and the electrodes 8, together with the resistive material 6.*
4. *Screen scanning is made on the bias through out of phase signals."*

REPUBLICA SOCIALISTĂ ROMÂNIA

DIRECŢIA GENERALĂ PENTRU METROLOGIE, STANDARDE ŞI INVENŢII
OFICIUL DE STAT PENTRU INVENŢII

BREVET DE INVENŢIE

Nr. 5olo8

acordat BALTAG OCTAVIAN IOAN din Iaşi,
Republica Socialistă România

pentru invenţia cu titlul " Traductor curent-imagine"

conform descrierii şi desenelor alăturate (4 file), formînd obiectul dosarului nr. 54523 din 17 august 1967, ora 1o[1o]
cu prioritate de la - - -

Prezentul brevet se acordă pe baza legilor în vigoare, pe răspunderea exclusivă a solicitanţilor atît din punct de vedere al noutăţii, paternităţii, valorii, posibilităţii de realizare sau utilităţii, cît şi din punct de vedere al exactităţii descrierii şi desenelor, pe termenul de la 17 august 1967 pînă la 17 august 1982

PRIM ADJUNCT AL DIRECTORULUI GENERAL,

Bucureşti, 12 decembrie 1967

ROMÂNIA
OFICIUL DE STAT PENTRU INVENŢII ŞI MĂRCI

DESCRIEREA INVENŢIEI 50108

Perfecţionare la invenţia nr

Înregistrat: 17.08.1967 Dosar: 54523

Prioritate:

Publicat în buletinul nr. 6

Publicat: 1968

Int. Cl.[6]: H 01 J 11/00

Acordat brevet de invenţie, titularului:
Baltag Octavian Ioan, Iaşi

Acordat certificat de autor, autorului:
acelaşi cu titularul

(54) Traductor curent-imagine

(57) Rezumat:

Prezenta invenţie se referă la un dispozitiv de transformare a semnalelor de videofrecvenţă în imagini luminoase. Traductorul curent-imagine pentru televiziune este alcătuit din:

a - o reţea de electrozi transparenţi (2) pe care este aplicată pelicula de fosfor electroluminiscent (3);

b - o mască perforată (4) şi materialul rezistiv (6) aflat în golurile amintitei măşti;

c - elemente neliniare, formate din celulele (5) în care se află un gaz inert şi electrozii (8), împreună cu materialul rezistiv (6);

d - exploatarea ecranului se face pe diagonală, prin semnale defazate.

Fig. 11. Patent RO 59,108, Current - image transducer

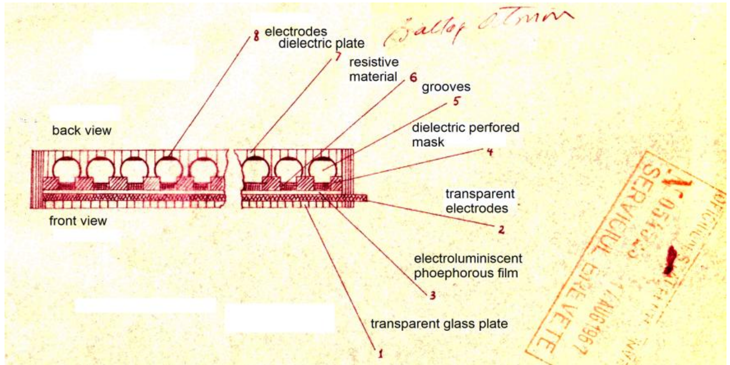

Fig. 12. Cross section of the TV display

At this patent, it is interesting that the technical novelty elements mentioned in the claims are found entirely in the plasma television screens developed later by the dedicated producers after 1970.

In 1968, R. Donald files a patent application for a plasma television screen and takes-out in 1971 the patent entitled ”*Plasma panel display device”*, Fig. 13, with the number US 3,573,531 out of which we present here the description of the solution [45]:

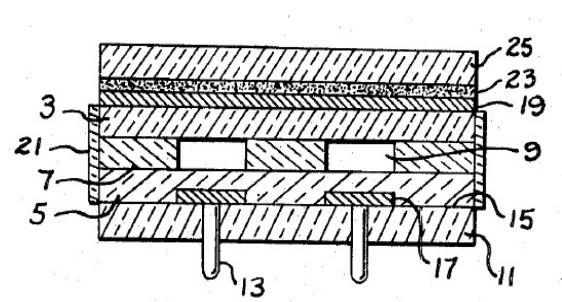

Fig. 13. Plasma TV display

”Referring to the drawings, Fig. 1 illustrates a preferred embodiment of high contrast plasma display device which includes a transparent insulator layer 3, such as glass for instance. Also, an opaque insulator layer 5, which is preferably in the form of a black glass frit, is spaced from the transparent insulator layer by a plurality of spaced opaque insulator segments 7. Thus, the transparent and opaque insulator layers 3 and 5 respectively, and the spaced opaque insulator segments 7, form a plurality of ***cavities 9****, intermediate thereto. An insulator substrate II, such as glass for example, has a plurality of electrical connectors I3 embedded therein and extending there through. The connectors 13 are at least flush with one surface I5 of the substrate II, which is bonded to the opaque insulator layer 5, and a plurality of spaced electrical.”*

Also in 1968, Masanori Watanabe from Matsushita Electric Industrial Co, Ltd, files a patent application for a plasma display. The patent, entitled *“Fluorescent screen display panels”* [46], Fig. 14, is assigned in 1971:

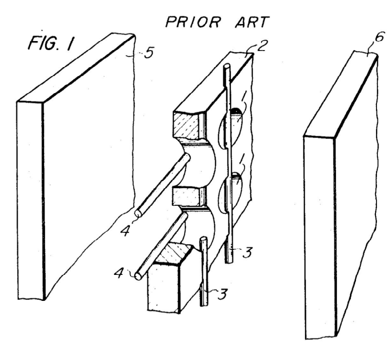

Fig. 14. Matsushita electric industrial fluorescent screen display panels

A display panel useful for realizing a very thin panel-shaped letter or figure display device or a panel-shaped TV set, wherein the small region of the fluorescent screen may be illuminated by the bombardment of charged particles; the control electrode, formed by providing a plurality of parallel metal electrode sheets on one principal surface of the insulating substrate, a plurality of parallel metal electrode sheets on the other principal surface orthogonal to the direction of arrangement of said former metal electrode sheets and holes penetrating through the insulating substrate at the part where said metal electrode sheets intersect across the insulating *sub strate, being made to contact the discharge plasma generated between the discharge electrodes; electrons or ions being taken out of the discharge plasma by applying a signal voltage to said metal electrodes of the control electrode and made to pass through the holes selectively, the transparent electrode comprising the fluorescent screen being provided on the side opposite to said discharge plasma with respect to said control electrode in parallel with said electrodes; and the electrons or ions passing through said holes being accelerated and made to collide with the fluorescent screen by the high voltage applied to said transparent electrode.*

In 1972, Mitsubishi (and, independently, Hitachi), demonstrates the possibility to obtain images with grey hues using an a.c. controlled memory display. The technique used to obtain grey nuances consisted in writing and deleting each image pixel several times within an image frame, the grey hue resulting from the time interval when the corresponding pixel is displayed. In fact, one has also used a binary display sequence, but with variable duration. This was the first step to the utilization of the *Plasma Display Panels* (PDP) – type devices in television.

7. CONCLUSION

The evolution of the TV screen from Nipkow's disk to the up to date ones has lasted some tens of years. An attempt to systematize these stages can be as follows:

- 1936 can be considered the year when Tihanyi' ideas concerning plasma TV appeared in written documents found in the '*MTA Archive of manuscripts"*. With these documents, Tihanyi can be considered as a precursor of plasma television;

- 1954 marked the moment when the vacuum electronics industry realized the first flat electronic system of image representation, with military applications and laboratory instruments, namely two spots oscilloscope;

- 60s' of the last century marked the appearance of luminous panels for image representation using gas discharge lamps for each image element - pixel; this was followed by the transition to technologies that integrated in the same structure the discharge cells controlled through a rectangular electrodes network, the first applications being in the binary representation of certain logical states;

- 1967 marked the year when was issued the first patent, related to the utilization of a plasma image transducer, which permitted image representation in grey hues.

Plasma has not disappeared from the interests of researchers and manufacturers of electronic equipments; for instance, the plasma alphanumeric display devices from Burroughs Corporation, who was a computer elements manufacturer, introduced at the beginning of the 1970s', plasma alphanumeric display elements, with the generic name of display screens with gas or gas and plasma. Their life initially began as alphanumeric indicators, also names Nixie tubes, with seven segments, which became popular due to their aspect and orange color. These were especially popular up to 1990, when were replaced by display systems with LED and liquid crystals.

The plasma TV dominated the market due especially to image quality - resolution and luminous efficiency; they have been produced in a wide range of dimensions, their diagonal exceeding 100 inches (Samsung and Panasonic in 2005). The potential of the plasma systems is quite high, being in competition with the systems that use liquid crystals and LED.

Nowadays, after more than 50 years from the first inventions concerning plasma utilization in television, the plasma TV sets are waiting for new solutions that will replace the plasma display, making them to become history together with precursors: Nipkow's disk, revolving mirrors and cathode tube.

One tendency consists in continuing to use medium and large size displays of curved LED and micro-LED type. It is possible that the development of LED- type devices, such as Organic Light Emitting Diode – OLED, to dominate the market of extra-flat OLED displays, due to their advantages: wider viewing angles, high brightness, low power consumption, smaller operating voltages. The OLED technology uses intelligent pixels that generate light individually, such that the colors are much closer to the natural ones, thus improving image definition.

Another tendency related to new LED type technologies consists in the utilization of QLED display type, a lighting technology that rivals with OLED, the offered brightness levels and color range being at least equal. Though the QLED pixels are not lighted individually, this does not affect the image definition. QLED is an alternative to the already classical LED technology.

Still another technology refers to the utilization of pixels made of “Light Emitting Diode Liquid Crystal Display” LED-LCD. This technology makes use of backlight LED, having in front a “Liquid Crystal Display” – LCD.

Starting from “Mini LED” technology, another technology was developed, named ”Quantum, NanoCell, Emitting Diode” – QNED, that promises a better control of lighting for certain display zones.

It is expected that the “Quantum Dot” technology, also named “Triluminos” to appear on the market as a potential competitor of the present technologies. This technology consists in the utilization of some quantum points - pixels consisting of seminonductor nanocrystalls that generate monochrome light corresponding to basic colors.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Langmuir I. Oscillations in ionized gases Proceedings of the National Academy of Sciences of the United States of America, 1928;14:627-636.
2. Schnitger H. Patent, US 2,214,511, Gas discharge device.
3. Johnson EO. Patent US 2,679,016, Gas discharge device.
4. Jacoby GE, et al. Patent US 2,929,962 Gas discharge device.
5. Crowther GO. Patent US 2,823,336, Cold-cathode counter tube circuit arrangement.
6. Irvine JA, et al. Patent US 2,975,329, Electronic counters.
7. Collins GG. Patent US 3,019,365 Gas discharge device.
8. Nolan JF. Gas discharge display panel, 1969 International Electron Devices Meeting, 29-31 Oct; 1969, DOI: 10.1109/iedm.1969.188115.
9. Lenard WM. Gensler RW, Hall MS. Light-addressable gas-discharge display panel, 1971 Int. Electron Devices Meeting, 11-13 Oct; 1971, DOI: 10.1109/IEDM.1971.188423.
10. Kurahashi K, Tottori H, Isogai F, Tsuruta N. Plasma display with grayscale, Proc. SID Int. Symp., New York. 1973;72–73.
11. Slottow HG. Plasma Displays, IEEE Transactions on Electron Devices, 1976;ED-23(7):760-772.
12. Weber LF. History of the Plasma Display Panel, IEEE Trans. On Plasma Science, 2006;34(2): 268-278.
13. Uchiike H, Takayoshi H. Historical View and Current Status of Plasma Displays, 2003;41-51:0-7803-7883-0/03/$17.00 © 2003 IEEE.
14. Edward HW. A History of Color Television Displays, Proceedings of the IEEE, 1976;64(9):1331-1338.
15. Shinoda T. Plasma display technologies for large area screen and cost reduction, IEEE Transactions on Plasma Science 2006;34(2):279-286, DOI: 10.1109/TPS.2006.872453
16. Milind KP. Plasma Display Panel, Seminar report, Dr. Babasaheb Ambedkar, Tech. Univ., Lonere; 2012.
17. Available:http://www.hungarianhistory.com/mszh/etihanyi.htm, (accessed April 2021).
18. Horváth G. Technikatörténet emc kompatíbilis lapos képcsô – anno 1936!, Lix. Évfolyam 2004; 1:52-55.
19. *** Proposed Television Sets Would Feature Thin Screens, Popular Mechanics, 1954;111.
20. Aiken WR. "History of the Kaiser-Aiken, thin cathode ray tube," in *IEEE Transactions on Electron Devices*, 1984;31(11):1605-1608, DOI: 10.1109/T-ED.1984.21758.

21. *** Thin Tube Foretells Wall TV and Sky View for Air Pilot, Popular Mechanics, 1958;104.
22. *** Flat Screen TV in 1958, Blog: Modern Mechanix yesterday, Tomorow, Today, Available:http://blog.modernmechanix.com/flat-screen-tv-in-1958/ (accessed Febr. 2021).
23. *** Oral History: William Ross Aiken, Available:https://ethw.org/Oral-History:William_Ross_Aiken, (accessed Mai 2021).
24. *** "Geer Experimental Color CRT". www.earlytelevision.org, Available:https://www.earlytelevision.org/geer_color_crt.html, (accessed April 2021).
25. Aiken WR. US 2,795,731, Catode Ray Tube.
26. Aiken WR. US 2,837,691, Electronic Device.
27. Aiken WR. US 2,850,670, Electronic Device.
28. Aiken WR., US 2,864,033, Polar Coordinate Tube.
29. Aiken WR., US 2,864,970, Electronic Device.
30. Aiken WR., US 2,879,443, Electronic Device.
31. Aiken WR., US 2,928,014, Electronic Device Ray Tubes.
32. Aiken WR., US 2,904,722, Electronic Control System.
33. Aiken WR., US 2,930,930, Electronic Device.
34. Aiken WR., US 2,955,231, Electronic Selector Device.
35. Aiken WR., US 2,978,601, Electronic Control System.
36. Aiken WR., US 3,313,970, Flat Cathode Ray Tube by Tunnel Containing Magnetic deflector.
37. Aiken WR., US 3,507,020, Method of Making an Electron Gun for Cathode Ray Tube and Jig Assembly therefor.
38. Dano PK. Patent US 3,356,898, XY Glow lamp display with switch from igniting to holding voltage.
39. Steinmeyer DJ. Patent US 3,300,581, Flat screen electroluminescent X-Y display.
40. Hashimoto K. Flat screen television display apparatus.
41. Bitzer DL, Slottow HG, Willson Robert, R. Patent US 3,559,190, Gaseous display and memory apparatus; 1971.
42. Baltag O. Current - image transducer, Patent RO 50108; 1967.
43. Baltag O. Plasma Display – History of a Invention, The XVIII-th International .Exhibition of Inventics, Research and Technological Transfer "Inventica 2014"; 2014.
44. Baltag O. Pages from the history of plasma television, Bull. of the Museum of Science and Technology "Stefan Procopiu", Iasi. 2020;14:75-82.
45. Kerstetter RD. Patent US 3,573,531, Plasma panel display devices.
46. Masanori W. Patent US 3,622,829, Fluorescent screen display panels.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/70034