

# **Inventing Television:**

## **Transnational Networks of Co-operation and Rivalry, 1870-1936**

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## **Abstract**

### **The University of Manchester**

**Paul Marshall**

**Doctor of Philosophy**

#### ***Inventing Television: Transnational Networks of Co-operation and Rivalry, 1870-1936***

In this thesis, I seek to understand what shaped the development of television, tracing the technology back to its earliest roots. In existing literature, the history of television in its formative years (before World War II), has largely been presented in technologically deterministic terms, culminating in the ‘goal’ of adding ‘sight to sound’ – producing a wireless set with pictures. Most of the existing literature focuses on ‘hero’ figures such as British inventor John Logie Baird and his electro-mechanical television systems, or on corporate narratives such as that of RCA in the United States in developing all-electronic television. In contrast to such an approach, I will concentrate on the transnational networks linking individuals and companies, and on the common external factors affecting all of them. Some networks could operate simultaneously as rivals and collaborators, as was the case with companies such as Marconi-EMI in Britain and RCA in the United States. Senior managers and researchers such as Isaac Shoenberg at Marconi-EMI and Vladimir Zworykin at RCA played significant roles, but so too did relatively obscure figures such as Russian scientist Boris Rosing and British engineer Alan A Campbell Swinton. I will draw on newly available sources from Russia and the USSR, on over-looked sources in Britain and the United States, and on replicative technology to re-examine the story. The new material, coupled with the transnational networks approach, enables fresh insights to be gained on issues of simultaneity of invention and on contingency in the development and initial deployments of the technology. By using these fresh primary sources, and by re-interpreting some aspects of the numerous existing secondary sources, I will show that the ‘wireless with pictures’ model was not inevitable, that electro-mechanical television need not have been a technical cul-de-sac, and that in Britain at least, it was the political desire to maintain and extend the monopoly of the BBC, which effectively funnelled the technology into the model so familiar to us today.

## **Declaration**

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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## **Dedication**

To my late father, Eric.  
He never had the chance to go to university.  
He would have loved to have had the opportunity  
to be able to write something such as this.

## Acknowledgements

My thanks must begin with gratitude to my supervisor, James Sumner, for his guidance and timely help over the last six years. The time has gone by very quickly and the learning process has, at times, been steep. James has patiently steered me through my work and pointed me in the right direction with regard to so many aspects of this thesis and in the intricacies of the history of science and technology. What more can be said of such a dedicated and professional supervisor. My second supervisor, Jeff Hughes, has provided much appreciated supportive help from the very beginning, making the nuts and bolts of university life work fit together, running the wonderful reading group and providing insights into the overall direction of my work which I had missed.

When I began this work, I was employed by a small British company called SEOS Displays Ltd., and it is to the former directors of that delightful band of engineers that I must offer my thanks for their permission and active encouragement to pursue this endeavour. In particular, my thanks are due to one director in particular, Stephen Elmer, for his on-going encouragement and support. Also from this early period, I am in debt to John Trenouth, the former Senior Television Curator of the National Media Museum in Bradford, for his advice and help in smoothing my path.

As a mature student with a full-time job in engineering, and working on this from home on a part-time basis, there has been much juggling between work, domestic life, family commitments and my other professional activities as an engineer. My wife, Jill, has had to bear the brunt of this, especially in the concluding stages. However, there have been enjoyable trips across the country and abroad in search of interesting people and information. My thanks go to her for that continuing and patient support. Most of my friends have also been roped in at various times to act as a sounding board and to offer advice. In particular, Dave, Dicky, Sam, Geoffrey, Richard and Rick have all had to put up with endless stories about long-dead engineers and inventors.

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My archival source hosts at the IEE (I refuse to call it the IET), the BBC, RTS, RCA (Sarnoff Library) , the Marconi Archive (Bodleian Library) and the Royal Mail have all been most gracious in coping with a 'teleworker' and processing photocopies and e mails with prompt responses. I am particularly in debt to Sir John and Lady Swinton whose knowledge and guidance concerning A A Campbell Swinton was most helpful.

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# Glossary

**Amplifier**

An electronic device for magnifying the strength of electrical voltages and currents.

**Bandwidth**

The amount of frequency space required by a signal.

**Black Level**

In a television picture; that part that has no luminosity, no output.

**Blanking**

Part of the *video* signal stream deliberately taken to *black level* to hide the process of *flyback*.

**Cathode Ray Tube**

A class of electron tubes exploiting the properties and characteristics of cathode rays.

**Coaxial cable**

A type of transmission line common in television work formed from concentric conductors.

**Deflection**

The action of moving a focussed electron beam in a CRT, vertically (*frame* or *field*) and horizontally (*line*).

**Diode Valve ('valve' is a 'tube' in the USA and a 'lampe' in Russia)**

An electron tube which exploits thermionic emission, giving the property of only passing an electric current of one polarity.

**Electron Multiplier**

A type of electron tube that performs the function of an *amplifier* by exploiting the phenomenon of *secondary emission*.

**Emiscope**

The Marconi-EMI version of the RCA *kinescope* or display CRT.

**Emitron**

The Marconi-EMI version of the RCA *iconoscope* or *pick-up* CRT.

**Fernseh**

German television company, also the word for television in German.

**Field**

One complete television picture in a non-*interlaced* picture. Also refers to the vertical *deflection* of the image.

**Flyback**

The period in the horizontal or vertical *deflection* during which an electron beam is rapidly re-positioned back to its origin.

**Flying Spot Scanner**

A class of *pick-up* that uses reflected or transmitted light from a *scanning* device which is then picked up by *photocells*.

**Frame**

One complete television picture in an *interlaced* picture (there are two *fields* in one frame of an *interlaced* system. Also refers to the vertical *deflection* of the image.

**Iconoscope**

A CRT based *photoemissive pick-up* developed by RCA.

**Image dissector**

An *electron multiplier* based *photoemissive pick-up* developed by Philo Farnsworth.

**Image orthicon**

A World War II developed pick-up tube combining the strengths of the *iconoscope* and the *image dissector* types.

**Interlace**

A technique that allows television *fields* to be interleaved together reducing the *bandwidth* requirement without sacrificing flicker performance.

**Kell Factor**

Named after Ray Kell of RCA; a reduction factor to be applied to the system horizontal resolution due to the sampling nature of the vertical line structure. This makes the effective horizontal and vertical resolution approximately equal.

**Kerr Cell**

Named after John Kerr; a device that alters the plane of polarisation of light using a magnetic field.

**Kilocycles per second**

Abbreviated to Kc/s, now KHz

**Kinescope**

RCA name for a display CRT.

**Light Valve**

A generic term for any device that controls the amount of light passing through it.

**Line**

One horizontal *sweep* of an electron beam.

**Marconi-EMI**

British company founded in 1934 to develop electronic television merging the television interests of Marconi's Wireless Telegraph Co. Ltd. and Electrical and Musical Industries Ltd.

**Megacycles per second**

Abbreviated to mc/s, now MHz

**Mirror Drum**

A revolving cylinder covered in very precisely angled mirrors used in mechanical television as both a display and a pick-up.

**Nipkow Disc**

A mechanical scanning and sampling scheme for both pick-up and display invented by Paul Nipkow.

**Orthicon**

A pick-up tube based on the *iconoscope* but with a two sided *target*, making the device orthogonal in form.

**Oscillograph**

Also known as an oscilloscope; an electronic instrument based on a CRT used for observing the variations in voltages with time.

**Photocathode**

An electrode that exhibits *photoemission*.

**Photocell**

A generic term for any device exhibiting *photoelectric* effects.

**Photoconductive**

A material or device exhibiting changes in electrical resistance with varying incident light.

**Photoelectric**

A generic term referring to any device or material that generates any kind of electrical response when stimulated by light.



**Photoemissive**

A generic term referring to a material or device emitting electrons when stimulated by incident light.

**Pick-up**

A generic term for any device acting as a camera in a television system.

**Pixel**

The smallest resolvable part of an image in a television system.

**Radiovision**

An alternative term for television, preferred by the Westinghouse Electric Manufacturing Co.

**Radiomovies**

An alternative term for television, coined by C F Jenkins.

**Radiotelephot**

An all-electronic television system devised in the USSR.

**Sawtooth (waveform)**

A fundamental *deflection* type used to create a forward *sweep* and a fast *flyback*.

**Scanning**

Fundamental system used by all practical television systems to break an image up into manageable sections using repeated movements.

**Scophony**

A British television company of the 1930s; invented a mechanically scanned light valve based large screen television display bearing the same name.

**Secondary emission**

In a *photoemissive* device, unwanted signals produced by released electrons re-striking a *photocathode* and causing further electrons to be emitted. Used to advantage in the *electron multiplier*.

**Selenium Cell**

A *photocell* using the element selenium based on the principle of *photoconductivity*.

**Sideband**

Part of a radio transmission where the impressed information exists.

**Storage**

A desirable characteristic of most pick-up devices whereby when not being addressed by the sampling electron beam the incident light is allowed to build up (integrate) between frame times. This leads to much enhanced sensitivity.

**Sweep**

A repeated motion of a *deflection* system, usually a *sawtooth* in television work.

**Synchronising Pulse**

Part of a video signal designed to keep the receiving scanning in synchronism with the transmission.

**Target**

The area in a pick-up device, such as an *iconoscope*, where an electron image of the incident optical scene is created and/or stored.

**Telecine**

A device for translating film images into a television format.

**Telegraphy**

The sending of Morse code by either wire or wireless.

**Telephony**

The transmission of the human voice by either wire or wireless.

**Telescopy**

An alternative name for television favoured in Russia in the early twentieth century.

**Televisor**

A mechanical *Nipkow* disk based display as marketed by Baird Television Ltd.

**Thermionic**

Any device that uses the principle of the emission of electrons from a heated electrode in a gas filled or evacuated envelope.

**Triode Valve (*tube* in the USA, *lampe* in Russia)**

A three electrode *thermionic* device capable of *amplification*.

**Velocity Modulation**

An alternative television system of the 1930s, still using CRTs, but achieving brightness modulation by variable duration scanning.

**Video**

From the Latin, *to see*, but from the 1930s referring to the visual part of a television transmission. The term vision signal was common in Britain.

## Acronyms and initialisms

AF.....	Audio Frequency
AIEE.....	American Institution of Electrical Engineers (USA)
AM .....	Amplitude Modulation
ARL.....	Admiralty Research Laboratory (Britain)
AT&T .....	American Telephone and Telegraph (USA)
BBC.....	British Broadcasting Corporation (Britain)
BTL .....	Baird Television Limited (Britain)
CBS .....	Columbia Broadcasting System (USA)
CCD .....	Charge Coupled Device
CRO .....	Cathode Ray Oscilloscope
CRT .....	Cathode Ray Tube
CW .....	Continuous Wave
DSIR.....	Department of Scientific and Industrial Research (Britain)
EMI .....	Electrical and Musical Industries (Britain)
FCB .....	Federal Communications Board (USA)
FCC .....	Federal Communications Commission (USA)
FRC .....	Federal Radio Commission (USA)
FM.....	Frequency Modulation
GE .....	General Electric (USA)
GEC.....	General Electric Company (Britain)
GPO .....	General Post Office (Britain)
HF.....	High Frequency
HMV .....	His Master's Voice (Britain)
IEE.....	Institution of Electrical Engineers (Britain)
IF .....	Intermediate Frequency
kc/s .....	kilocycles/sec
LF .....	Low Frequency
Mc/s.....	Mega cycles/sec
MF.....	Medium Frequency
MWTCO. ....	Marconi's Wireless Telegraph Company (Britain)
NBC .....	National Broadcasting Company (USA)
NHK .....	Nippon Hoso Kyokai (Japan)
OED .....	Oxford English Dictionary (Britain)
RADAR.....	RADio Detection And Ranging
RCA .....	Radio Corporation of America (USA)
RDF.....	Radio Direction Finding
RF.....	Radio Frequency
RMA.....	Radio Manufacturer's Association (Britain)
RSGB .....	Radio Society of Great Britain
RTS .....	Royal Television Society (Britain)
STC .....	Standard Telephone and Cables (Britain)
TAC.....	Television Advisory Committee (Britain)
TSC .....	Technical Sub Committee (Britain)
usw .....	ultra-short wave (now VHF)
VHF.....	Very High Frequency

# Chapter 1

## *Introduction and literature review*

### **1.1 Introduction**

On November 2<sup>nd</sup> 1936 the BBC inaugurated its high definition television service, with a potential audience of ten million people in and around the London area. A scant twelve years earlier in 1924 the eminent Scottish electrical engineer A.A. Campbell Swinton had announced at a lecture about television that: ‘— it is probably scarcely worth anybody’s while to pursue it.’ So what led to this burst of technological development and what shaped it? One year after his lecture, tiny, flickering, blurred silhouette images were crossing table-tops, in five years they were being broadcast on a regular basis and then a rapid sequence of developments began to increase the size, brightness and above all, the sharpness of the pictures. The developments culminated in a system of television which we would recognise today. I seek to understand what happened during those dozen or so years by tracing the technology from its earliest roots.

In existing literature, the history of television in these formative years has largely been presented as a series of predetermined processes, all culminating in the goal of adding ‘sight to sound’, and thus producing a ‘wireless set with pictures’. Much of the existing literature focuses on ‘hero’ figures such as British inventor John Logie Baird, or on corporate narratives such as that of the Radio Corporation of America (RCA). In contrast to that approach, I will concentrate on the collaborating, yet often competing, networks linking individuals and companies, and on the common external factors which affected them all during the pre-history of the technology from about 1870 to 1936. My methodology has been to follow as many as possible of the transnational and national networks formed between individuals, companies and government bodies which grew rapidly in the 1920s and 1930s, shaping the future direction of television. It was in this period that inventors gave practical form

to the late nineteenth-century idea of ‘distant electric vision’, its eventual form being moulded by commercial and political factors.<sup>1</sup>

The ‘wireless set with pictures’ model was not the first use proposed for a ‘distant electric vision’ machine. The first imaginings of the technology appeared in the late nineteenth-century, beginning the shaping process of the invention with speculation about its uses. The first stirrings were in the late 1870s, becoming inspiration for scientists such as Shelford Bidwell, Adriano de Paiva and George R. Carey, writer Jules Verne and artists such as George du Maurier and Albert Robida. All envisaged the proposed technology as extending the still-new telephone into the visual domain, adding the visual sense to the existing aural ‘point-to-point’ communication. By the mid-1920s, a form of television based upon electro-mechanical principles (as suggested by inventors in the late nineteenth century), had been demonstrated in public. By the late 1920s, a second potential application for the technology emerged, that of adding pictures to the new and popular medium of wireless. Telephone companies and broadcasters began to adopt and experiment with television systems which could work over existing telephone and broadcasting networks. Applications related to telephony failed to gain traction, not just because of the difficulties and limitations of the electro-mechanical technology, but because the desire to add pictures to the telephone was not strong.<sup>2</sup> Broadcasting proved to be a more hopeful proposition, and there was a brief period of enthusiasm in the late 1920s and early 1930s, when experimental television services based on the electro-mechanical television concepts began to appear throughout the Western world. Applied to

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<sup>1</sup> The idea of being able to see at a distance using electricity (in similar way to the telephone enabling hearing at distance), attracted many contemporary descriptions before ‘television’ was almost universally adopted in the 1920s. One such late-nineteenth century expression for the concept was ‘distant electric vision’, or simply ‘distant vision’, and it is this latter term which I will use generically. The expression ‘distant electric vision’ first known appearance in print is in French in 1889, see: Weiller, “Sur la vision à distance par l’électricité”, with the shortened form of ‘distant vision’ and ‘distant electric vision’ in English becoming popular terms amongst researchers and inventors in the late nineteenth and early twentieth century, an example being: Swinton, “Distant Electric Vision”.

<sup>2</sup> Transmissions had begun in the early 1930s in Britain, France, Germany, USSR and the United States, but the technical quality (and hence programme production values) were very low.

broadcasting, television did appear to interest the public, but the enthusiasm did not last for very long, largely because of the very poor picture quality possible.

During this period, the 'wireless with pictures' model itself began to evolve into two competing concepts: delivering live material to the home (just as wireless stations then did for sound), and the less prominent 'films to the home and/or public viewing room', effectively creating small cinemas. The older idea of a 'telephone with pictures' was stalled, but other potential applications began to appear, such as introducing live pictures of sport and national events to existing large cinemas, large screens for public information display, and new military applications such as aerial reconnaissance and night vision. None of these applications were viable with the electro-mechanical technology; the pictures were just too poor and the technology was not amenable to much improvement. However, electro-mechanical techniques had revealed the possibilities for a new medium, but such a concept was not a practical proposition with the early 1930s electro-mechanical technology. Television with much larger, brighter, sharper pictures (albeit much more expensive) was already in development in corporate laboratories based on the cathode ray tube (CRT), and considerable amounts of money and resources were being poured into the work to create a new mass-market product for deployment when the Great Depression eased.

The actual deployment of this 'better wireless with pictures' technology was largely governed by the politics of broadcasting. In Britain, the BBC monopoly, licensed by the General Post Office (GPO), held the reins, whereas in the commercial market of the USA, it was private broadcasters, regulated by the Federal Communications Commission (FCC). Most of the American broadcasters were linked to the large wireless manufacturers who would decide on the timing of any deployment of television. This would not be during the Great Depression, as television would almost certainly damage wireless set sales. In Germany, the Nazi Party pushed for the use of television as a propaganda tool and was able to launch a limited service by 1935. In Britain, the BBC, working closely with the British wireless industry, broke through the financial constraints of the Great Depression, to launch a full 'high definition' television service in late 1936. The term 'high-definition' was an actors' term and was used in the mid-1930s to differentiate the then new, all-electronic

television systems from the earlier 'low-definition' electro-mechanical systems. The British understanding of the term was any television system of at least 240 lines at 25 pictures per second, irrespective of whether the technology was all-electronic or electro-mechanical in form. 'Low-definition' television was defined as typically being a system providing 30 lines at 12.5 pictures per second.<sup>3</sup> What led to this rush to open the London high-definition television service? As I answer this question, I will show that the 'wireless with pictures' model was not inevitable, that electro-mechanical television need not have been a technical cul-de-sac, and that in Britain it was the desire to maintain and extend the monopoly of the BBC which funnelled the technology into the model so familiar to us today.

I have drawn on overlooked sources from Britain and the United States, and on newly available sources from Russia, to re-examine the narrative, focusing on the interplay of individuals and companies. By using these fresh sources, and by re-interpreting some aspects of the numerous existing secondary sources, I will explore the development of television beyond the deterministic tradition, examining the national and transnational networks which shaped the technology. These topics illustrate several areas of interest to historians of science and technology: questions about simultaneity of invention, the problems of patenting, dissemination of information, issues of contingency and of technological failure.

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<sup>3</sup> Report of the Television Committee 1935, Cmd. 4793, 9-10.

## **1.2 Literature review**

### **1.2.1 Framework for analysis**

Any new analysis of the early development of television, grounded in current approaches to the history of science and technology, has to engage with the vast and entrenched secondary literature written largely by authors from within the television industry, past and present. This literature is, in the main, internalist in its scope, reflecting technological determinism and only limited contextual commentary. It is surprising that television, as one of the major technological developments of the twentieth century, has largely been sidestepped by scholars of the history of science and technology. One of the few works written beyond the internalist tradition is a paper by innovation analysts Jan van den Ende et al., in which the authors briefly attempt a reappraisal of early television history. They state in their introduction:

We see that it may be difficult to demonstrate the role of contextual influences in the history of television, but hope our analysis contributes in indicating that such influences indeed existed, even on the basis of existing materials.<sup>4</sup>

In support of their claim that the contextual issues of the early history of television are potentially difficult to address, they cite Science and Technology Studies (STS) scholar, Wiebe Bijker and sociologist of science Michael Mulkay, who have both briefly commented on aspects of this issue.<sup>5</sup> Does the early history of television really present difficulties to current thinking in the field of the history of science and technology?

There are three established frameworks on which a broad survey of early television history could be tackled: firstly, the discredited and already expansively explored deterministic tradition; secondly, the social construction of technology (SCOT)

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<sup>4</sup> Ende, Ravesteijn, and Wit, "Early Development of Television", 14-15.

<sup>5</sup> Bijker, Hughes, and Pinch, *The Social Construction of Technological Systems*, 41-42; Mulkay, "Knowledge and Utility", 80.



model; and finally, the systems/network theory as advanced by Thomas Hughes.<sup>6</sup> The deterministic tradition, with its inevitable outcomes and machine centred approach to the history of technology, producing ‘master narratives’, has been the most dominant in the study of the history of early television. Some authors, such as, Russell Burns, Albert Abramson and Antony Kamm, have made some attempt to break away from this tradition. In Burns’ own ‘master narrative’, he claims that: ‘A contextual approach has been adopted for this history to stress the influence of one discipline upon another so that the evolution of television is seen from the perspective of the times and not from the standpoint of a later generation’.<sup>7</sup> This is a laudable aim, although in the course of the narrative, he leaves little space for alternative outcomes and ‘failed’ approaches.

The SCOT movement, with its emphasis on choices and ‘forking paths’, addresses the different social groupings who use and encounter technology. It is useful for examining the reasons for the failure or success of technologies, which has relevance in the study of early television, but incorporating economic and political factors into its methodology is difficult. SCOT considers that failures are also socially constructed and can reveal ‘hidden’ histories which the ‘master narrative’ approach often ignores. This is not the case with electro-mechanical television where extensive consideration has been offered, even if only indirectly by the technology producers such as broadcasters and manufacturers. SCOT focuses on the part users play in the shaping of technology, but the early history of television, at least until the early 1930s, has few ‘users’, only its inventors.<sup>8</sup> Whilst the principles of SCOT have attractions, it does not appear to be particularly useful for the study of a nascent technology, before wider, larger, groups of actors have begun to shape the initial path adopted.

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<sup>6</sup> Hughes, “The Seamless Web”, 287-291.

<sup>7</sup> Burns, *Television*, Preface, x.

<sup>8</sup> The application of the principles of Actor Network Theory (ANT) might conceivably be of use in this instance, but choosing which inventor would be problematical, especially as there is only limited primary material for so many of the human actors. An introduction to ANT, Latour, *Reassembling the Social*, outlines the principles.

In the study of the history of technology, the concept of failure and how to examine and interpret ‘failed’ technologies, products and systems has inspired scholarly discussion in recent years about what ‘failure’ means. One such example is the study by historian Hugh Torrens about a ‘lost’ form of internal combustion engine, leading to ‘hidden’ histories and a continuing saga of neglect by historians.<sup>9</sup> Torrens underlines the complexity of ‘failure’ brought on by bad publicity, litigation, personal circumstance and changing commercial markets. He concludes with the lament that such ‘failures’ can be hidden from history as personal and corporate records can be lost or simply fall from view. A significant analysis of the context of failure is offered by the historian of science and technology, Graeme Gooday, who advises us to consider a candidate ‘failed’ technology (be it a system, a machine, a technique or combination of all three), in the light of its place in time, geography and society.<sup>10</sup> An alternative environment alters the reference frame for how we consider a technology as a success or a failure. In some other contextual existence, ‘failure’ could become ‘success’. With machines and systems, the question arises as to whether it is the failure of the hardware or its environment. This is a subjective and relative issue, especially with regard to hardware and what constitutes an ‘acceptable’ level of performance. The history of television presents many issues, challenges and contradictions in this area, making it a rich area for study in this regard. Although the label of ‘failure’ has been applied to many of television’s technologies and systems, they have been studied at length and in great detail. I am thinking in particular of electro-mechanical television and its ‘failed’ deployments in television services; could they have been a success? I will examine the possibility that such systems could have been successful in a different environment.

Whilst not forgetting the principles of SCOT, I have been greatly influenced by Hughes’ writing on networks and systems, and I have used his book, *Networks of Power*, as a model for my broad sweep survey.<sup>11</sup> Hughes’ work is a study of electrification in Western society between 1870 and 1930, and he engages with much of the same contextual history, and across almost the same time frame as that of

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<sup>9</sup> Torrens, “A Study of ‘Failure’”.

<sup>10</sup> Gooday, “Re-writing the ‘book of blots’”.

<sup>11</sup> Hughes, *Networks of Power*.

early television. His base is also transnational, although limited to the United States, Britain and Germany. These countries were also the dominant ones in the early history of television, but with the addition of pre-revolutionary Russia in the early phases of development. A major difference is that Hughes describes systems which evolved and grew steadily throughout his specified time period, whereas over this same time-frame the development of television was largely stalled; only achieving substantial investment and growth in the mid-1930s. Furthermore, his studies include notions of technological momentum (a vestige of a belief in a form of technological determinism) a phase which the development of television did not exhibit until post-World War II, during the 'golden-age' of television expansion in the 1950s.

My interpretation reflects two levels of network activity, the national and the transnational, but both are inextricably linked by the individual actors and corporate histories. Hughes has observed that problem solvers, be they engineers, scientists, technologists or inventors, do not respect boundaries, whether of discipline or of geography, and this is certainly validated in the case of the invention of television.<sup>12</sup> The networks I follow begin in the late 1870s merely as a loose association of a small number of like-minded individuals, bonded by an interest in the intellectual challenge of creating a 'distant electric vision' machine. The interest is transnational, with comment and ideas from around the world. The number of people involved grows slowly, and then by the turn of the century, declines. Geographically, the interest spans Russia, Britain, France, Germany and the United States, with secondary influences from Italy, The Netherlands, Australia, Portugal and Japan. By the end of the Great War, interest had revived and larger national networks formed, becoming increasingly more important as the technology became a limited reality. Connections formed between government regulatory bodies, companies, broadcasters, learned societies, amateur enthusiasts and politics.

At the same time, throughout this period, the transnational nature of the relationships was maintained and strengthened, largely across the same core countries of Russia/USSR, Britain, Germany and the United States. By the early 1930s, the

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<sup>12</sup> Ibid., Preface, x.

principal transnational networks were organised around two industrial groupings, both straddling the Atlantic and having to work with diverse national government policies of television broadcasting. As development work yielded practical results, national strategies and networks then gained traction, but underlying these, the transnational linkages remained and worked, almost invisibly, to shape the future direction of television.

Differentiating between simultaneity of invention and straightforward industrial co-operation is an analytical necessity in the history of television, but the narrative, having been recalled and shaped by so many authors, seduces researchers, inviting the historian to take sides. Recognising and proving simultaneity of invention is not easy as it can involve negative arguments, attempting to prove that individuals were not at the same conference or that they did not see a certain paper or journal. Much of the time it is a question of probability with no hard evidence to support either case. The 1922 paper by William Ogburn and Dorothy Thomas, which suggests that inventions and scientific discoveries are largely inevitable, is the founding work on this issue and the question remains a subject of much debate amongst historians of science and technology.<sup>13</sup> The paper suggests that there are four stages in the life-cycle of invention, the actual invention, its accumulation, then diffusion, and finally adjustment. My work only concerns that of the initial stage, the actual invention, and it is in that phase where the questions of simultaneity of invention arise. Ogburn went on to develop his ideas in later papers, but critics of his position, such as historian Merritt Roe Smith, cite his reliance on technological determinism as an established process as a serious flaw in his theories.<sup>14</sup>

The invention of television offers several potential examples of simultaneity of invention, many mired in the ‘firstism’ debates which I have already outlined. There can be no absolute proof, but later investigations of the simultaneity issue have used statistical analysis across numerous inventions and discoveries to investigate the phenomenon. The findings do confirm the statistical likelihood of multiple invention, although the specifics of individual fields of endeavour make any proof in

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<sup>13</sup> Ogburn and Thomas, “Are Inventions Inevitable?”.

<sup>14</sup> Smith, M. R., and Marx, L. *Does technology Drive History?*.

a given instance difficult.<sup>15</sup> This does affect the argument with regard to the influences of networks, and the question arises about how much is about technology transfer (whether formal or informal), and how much is due to the statistical likelihood of multiple invention? This requires careful consideration on a case by case basis, especially as both processes can exist simultaneously.

A complication in any analysis of simultaneity versus dissemination is the role of the patenting system and the national differences in how the process is carried out. A patent is not an indicator of an invention's worth, merely a claim. The United States (and also Germany) required 'reduction to practice', whereby a proof of principle working model had to be provided, whereas the British and French systems did not. Furthermore, any patented invention must pass through a period of secrecy as it must not be revealed; otherwise a patent will not be granted. However, once a patent has been granted, the information passes into the public domain via a whole new network of lawyers, journals, trade magazines, periodicals, clubs/societies and personal correspondence. At that point, the dissemination of information becomes potentially global. Understanding the strengths and weaknesses of the patenting systems is important in any study of early television as even long-expired patents from the late nineteenth-century have a part to play in the major developments of the late 1920s and early 1930s. The patent system also has a tendency to produce 'David and Goliath' patent interlocutory battles between individual inventors/small companies and large corporations. This is in addition to the inter-corporation battles which can be between notional collaborators. There are also issues of corporate power in terms of patent acquisition and legal interlocutory whenever it was required, and RCA was particularly active in those areas.

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<sup>15</sup> American psychologist, D K Simonton, has produced a considerable body of work on the statistical likelihood and psychology of multiple invention, with more recent works including: Simonton, "Independent Discovery in Science and Technology" and Brannigan and Wanner, "Historical Distributions of Multiple Discoveries". Simonton, "Stochastic models" and a chapter in an edited book; Sternberg, ed., *Handbook of Creativity*, in Chapter 6 'Creativity from a Historiometric Perspective', 116-129, in which he considers well-known figures in creative thinking in an attempt to define laws and statistics of creativity. This was followed by his 2004 book: Simonton, *Creativity in science*, devoted to the reasons for discovery and invention citing chance, logic, genius, and zeitgeist as major themes, all of which can contribute to cases of simultaneous invention.

The question of who were the users, potential users, and perhaps more importantly, the non-users of early television, has not been researched. Internalist histories, concentrating on the technology itself, conclude that electro-mechanical television was never going to be an acceptable and long-term viable technology. This conclusion is reached by solely considering the very small (an inch square), flickering, fuzzy and unstable image produced by the low-definition electro-mechanical systems, never considering that further technical developments could have succeeded in producing an acceptable picture. Whilst the technology was indeed rejected by the public because of the low-definition image quality, the responses of the small number of users did still shape the direction of the technology. 'User' carries several meanings in relation to technology use (and non-use).<sup>16</sup> With regard to early television the first category which comes to mind in a broadcasting application of the technology is the viewer (the consumer), but other significant categories include the inventors themselves, performers, engineers, technicians, sales people and manufacturing staff. The early high-definition television systems of the mid-1930s possess the same groups of actors, but with the added complication of much more political and commercial pressures being brought to bear on the shaping of significantly more expensive technologies.

There is some evidence from the scientific, engineering, journalistic and commercial actor groups about their experiences of the technology, but there is an almost complete lack of first-hand evidence from end-users (whether actual users or non-users). This is true of reactions to both high and low-definition television development. Without such material, a genuine broad study of the user shaping of television technology before World War II is hard to envisage. However, one approach which can be used to answer at least some of these questions is the technique known as replication. This method, as occasionally practiced by historians of science and technology, is the recreation of processes, techniques or machines which can enable a closer understanding of success and failure in historical context. The technique has not been used to any great extent, but the Oldenburg group in

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<sup>16</sup> Oudshoorn, *How Users Matter*, 18-19. The influence of the 'non-user' can be significant in shaping the direction of a new technology.

Germany has had some successes in this field, although primarily with regard to science rather than invention. An example of their work focuses on the replication of failed experiments with a view to develop understanding of lost experimental practice.<sup>17</sup> Other experiments have been carried out by historian Heinz Otto Sibum, also replicating experimental practice, with a view to examining controversies and uncertainties about methods.<sup>18</sup> As an electronic engineer by profession and training, I have been able to pursue investigations based on the use of such replicative technology applied to television. This has been an avenue of enquiry which has been a useful exercise in observing the development of television from the view-point of a contemporary actor, at least with regard to perceptions of image quality. No recreation can be perfect and all assessments are subjective, but such work has certainly answered questions which were not clear from primary documentation. I have created television equipment to emulate older television systems with the aim of exploring what television pictures probably looked like in the home, with particular attention on picture sharpness and image flicker. My principal replication study examines the differences between two rival television systems, one created by Marconi-EMI Ltd., and the other by Baird Television Ltd. (BTL) from 1936. As almost no photographs from television screens survive and contemporary descriptions are contradictory, using modern technology to emulate the systems creates a simultaneously comparable evaluation, independent of the contemporary actor's views.

Finally, there is the opportunity to engage with Russian and Soviet perspectives of the history of science and technology with respect to the invention of television. Some of the main narrative action occurs in one of the most important periods in Soviet history so far as influences on Western science and technology are concerned: the immediate post-civil war in the early 1920s which led to large scale emigration. A major question is just how important was Russian 'scientific emigration' to the development of science and technology in the West? In the case of the invention of television, this emigration appears to be a pivotal process with two of the main actors, engineers Vladimir K Zworykin of RCA, and Isaac Shoenberg of EMI, being

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<sup>17</sup> Heering, "Analysing unsuccessful experiments".

<sup>18</sup> Sibum, "Reworking the mechanical value of heat".

such émigrés to America and Britain respectively. Papers by Paul Hoch have described this scientific emigration and in his article about migration and scientific stimulus, he describes this ‘fruitful’ process as being of enormous benefit to science and technology, citing numerous examples.<sup>19</sup> In terms of a general analysis of the Russian context, works by Alexei Kojevnikov are helping to explain how Soviet science and innovation operated in the Soviet Union.<sup>20</sup> Kojevnikov offers useful clues as to how the Soviets organised their research and development and why some Soviet scientists and engineers with the means to escape to the West did so, whilst others stayed in the USSR.

### **1.2.2 Histories of television**

The invention and history of television has been covered extensively and frequently. There is a large audience for the subject amongst technologists, engineers, journalists, media professionals, sociologists and even television viewers. This interest has been fed by authors from fields such as media studies, engineers, economists, journalists, biographers and specialist television historians. Engineers, technologists and scientists writing on the subject have mainly concerned themselves with object-centred histories, ranging over the pre-World War II period to recent events. Journalists and biographers who have turned to the subject also cover the whole time frame, and have produced both in-depth studies of individuals and broad ranging surveys. There has also been interest shown by a few economic historians, interested in patents, monopoly and industrial organisation within the industry of television broadcasting, but their interest is largely post-World War II. An exception is a paper, written in 1950 by economist W Rupert Maclaurin, which describes in depth the highly complex patent and licensing issues surrounding the pre-World War II development of all-electronic television.<sup>21</sup>

Much disagreement has ensued over many years with regard to ‘firstism’ in the history of television. It is often nationalistic in form and usually centred upon the work of individual inventors or engineers. Some, but not all, of these arguments can

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<sup>19</sup> Hoch, “Migration and the Generation of New Scientific Ideas”.

<sup>20</sup> Kojevnikov, “Invention of Big Science”.

<sup>21</sup> Maclaurin, “Patents and Technical Progress”.



be resolved if the concept of multiple invention is accepted as being a ‘normal’ occurrence with regard to technologies such as television. Such questions of priority figured highly in the development of television in the 1920s and 1930s. Extreme examples of the championing of one nation, or individual or company as the ‘father of television’ or the ‘country which invented television’ can still be seen as nationalistic discourses in newspapers, or in the championing of a hero figure in technical journals and magazines. For the British public, it is undoubtedly John Logie Baird who invented television. The American public is less sure, but probably name RCA as the company and Philo Farnsworth as the individual. The Germans choose Paul Nipkow, and the Russians, Boris Rosing. This is part of television’s folklore; the complex reality of the narrative is lost completely, especially when the present television medium produces documentaries about this period of its own history.<sup>22</sup> A number of American books and papers ignore the British and German developments almost completely, and the reader is left believing that all-electronic television broadcasting began in 1941 in the United States.<sup>23</sup> Some of the existing British literature is also nationalistic, presenting the build-up and operation of the high-definition BBC television service as the end of a long technologically deterministic sequence with the British being ‘first’ in 1936.<sup>24</sup> There are exceptions amongst the American authors: Hubbell, the Fishers and Abramson all cover the British and German developments in deploying services well, although only as part of the road to American television broadcasting.<sup>25</sup> Pre-World War II German developments have not enjoyed the same coverage as British and American developments, although British and American documentary-makers have looked at ‘Nazi Television’.<sup>26</sup>

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<sup>22</sup> Giles, “The Fools on the Hill”; Yentob, “And Then There was Television”.

<sup>23</sup> Becker, “Hear-and-See Radio”, An American television service opened in 1939, but did not lose its official ‘experimental’ status until 1941. Books which largely ignore the British and German television services of the 1930s include: Magoun, *Television*; Udelson, *Great Television Race*

<sup>24</sup> Norman, *The Story of British Television*.

<sup>25</sup> Hubbell, *4,000 Years of Television*; Fisher and Fisher, *Tube*; Abramson, *Zworykin*.

<sup>26</sup> *Television in Third Reich Germany*, Channel 4.

Media specialists and sociologists generally assume that the technology ‘arrived’ in the early 1950s, presupposing that until that time, television was not an important sociological phenomenon. However, television’s pre-World War II history actually shaped how the 1950s incarnations came into being, as during that period and on into the early 1960s, television was principally a live event, distributed to large audiences in the form of a broadcasting network. As I have already noted, few historians of science and technology have ventured into the field, but there is some scholarly work in evidence, such as an analysis of picture-phone technology, early television in the Netherlands, and a few broad-brush examinations of general media history.<sup>27</sup>

Amongst this large number of histories, broad classes of work exist. There are accounts of the invention of television written from a largely a national perspective,<sup>28</sup> wide-ranging surveys of early television history,<sup>29</sup> and large numbers of biographies of engineers, scientists and inventors.<sup>30</sup> Baird, in particular, has attracted considerable attention: three PhD theses have been dedicated to researching his life and work,<sup>31</sup> and there are many biographies, ranging from the comprehensive work written by Anthony Kamm and Baird’s son, Malcolm Baird, to his own autobiography.<sup>32</sup> Much of the Baird biography is threaded around stories from his autobiography and from his early biographers writing in the 1950s such as that

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<sup>27</sup> Tightly focused accounts include: Lipartito, “Picturephone and the Information Age” and Ende, Ravesteijn, and Wit, “Early Development of Television”, with broad surveys by: Winston, *Media Technology and Society*; Winston, *Technologies of Seeing*; Briggs and Burke, *A Social History of the Media*.

<sup>28</sup> Burns, *British Television*; Norman, *The Story of British Television*; Swift, *Adventure in Vision*; Udelson, *Great Television Race*; Abramson, *The History of Television*.

<sup>29</sup> Burns, *Television*; Hubbell, *4,000 Years of Television*; Magoun, *Television*; Uralov, *Essays on the History of Television*; Fisher and Fisher, *Tube*.

<sup>30</sup> Moseley, *John Baird*; Schwartz, *Last Lone Inventor*; Stashower, *Boy Genius and the Mogul*; Godfrey, *Philo T Farnsworth*; Everson, *Philo T Farnsworth*; Burns, *John Logie Baird*; Abramson, *Zworykin*; Alexander, *Alan Dower Blumlein*.

<sup>31</sup> Hills, “British Military Television”; Brown, “Electronic Imaging”; Burns, “British television with special reference to John Logie Baird”.

<sup>32</sup> Kamm and Baird, *John Logie Baird*; Moseley, *John Baird*; Burns, *John Logie Baird*; Baird, *Sermons Soap and Television*.

written by former BTL vice-chairman, close friend of Baird, politician and journalist Sydney Moseley.<sup>33</sup> Baird was a charismatic character, alternating between great successes and crushing defeat, often pictured as the ‘little man’ against ‘the system’. The latest Baird biography, by Kamm and Baird, delivers a much more effective commentary to the existing narratives, using contextual material sourced from primary documentation.

A unique work, *Restoring Baird's Image*, written by engineer, Donald McLean, describes the technical recovery of electro-mechanical television video material recorded by Baird’s company in the late 1920s and early 1930s on gramophone records – a system known as phonovision.<sup>34</sup> The recordings could not be played back using contemporary techniques and the technology did not work as envisaged. However, McLean has managed to recover the signals using modern software techniques and has been able to display the recorded pictures, although the images are still only seconds long and not recognisable without reference to the known historical circumstances of their recording. The background to the making of the recordings reveals new material about Baird and his company, but phonovision had no significant effect on the development and deployment of television technology.

Of the broad-sweep internalist histories, there are two major factual accounts of the invention of television, both covering the technical developments in great depth and detail. Of the two, the work by Russell Burns, *Television: An International History of the Formative Years*, is the more comprehensive, and covers the broad international roots and development of the technology.<sup>35</sup> There are, however, omissions and blind spots, notably concerning Russian/Soviet television history and a complete absence of coverage of material concerning American television pioneer Ulises Sanabria. Engineer/historian Albert Abramson’s *The History of Television, 1880 to 1941*, concentrates much more on American work, but it is a thorough account of the core narrative as seen from an American perspective.<sup>36</sup> The strength

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<sup>33</sup> Moseley, *John Baird*.

<sup>34</sup> McLean, *Restoring Baird's Image*.

<sup>35</sup> Burns, *Television*.

<sup>36</sup> Abramson, *The History of Television*.

of Abramson's 1987 work lies in its interviews with the (then) surviving engineers and scientists who had worked on the development of television in the 1930s.

Besides the internalist broad-sweep histories, there also exists a range of works which ambitiously span television's history from the nineteenth century, right up to the 1960s and in some instances, beyond. Journalist Francis Wheen's *Television*, which was produced in support of a major British television documentary on the history of television, is one such work.<sup>37</sup> It spans a date range from the late nineteenth century to the 1980s and endeavours to show developments from around the world, both from a technical and cultural perspective. The later chapters focus on actual programme making and the finished programme material. Also spanning global developments across the whole time frame is historian Alexander Magoun's *Television – The Life Story of a Technology*, which is a much more focussed on the inventors and emphasises RCA's role in the invention and longer term development of television.<sup>38</sup>

Another broad approach, but unlike others attempting this span, is written largely from a communications studies perspective. *Television – An International History* spans the nineteenth century to the present day and reaches across countries, politics and culture.<sup>39</sup> The book is a collection of essays on many aspects of the development of television, ranging from a summary about the invention of television, to the development of television in Latin America. It is less strong on the commercial and technological development of television. Most of the emphasis of the book is post-World War II, but its general approach is international in its scope, and serves to illustrate the transnational boundary breaking nature of television in all its forms.

There are a few exceptions to this pattern of biographies, object centred histories and broad surveys. Media historian Brian Winston has examined the pre-World War II history of television as two chapter-length case histories, reflecting on what he

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<sup>37</sup> Wheen, F. *Television*. The fourteen hour Granada television series which led to this work was: Beckham, M, *Television*.

<sup>38</sup> Magoun, *Television*.

<sup>39</sup> Smith, *Television – an International History*.

describes as ‘the suppression’ of the technology by earlier media during much of its early development.<sup>40</sup> Another exception is Asa Briggs, noted as the ‘official’ historian of the BBC, who, in parts of the first two volumes of his five volume history of the BBC, presented a Corporation centred view of early television.<sup>41</sup> Besides this, he has, with a co-author, engaged with some of the pre-World War II history of television, but only as part of a work looking at the origins of all forms of media which seeks to take ‘history into media studies’ and ‘the media into history’.<sup>42</sup>

Alexander Magoun, former director of the Sarnoff Library (former custodian of the RCA Archive), has written about the consequences of this lack of scholarly television technology history.<sup>43</sup> He explains that the interest of the general public in the topic has spawned a huge number of books, websites and media documentaries, and that these are often biased and/or judgemental, sometimes being based on flawed evidence. This is borne out by even a cursory search of the World Wide Web, yielding large numbers of sites devoted largely to the technology and/or short biographies of the principal actors.<sup>44</sup> Generally, they offer virtually no insights into the factors shaping the invention of television, and many are little more than soap boxes for advocates of a particular ‘cause’ or hero. However, as Magoun points out, some of the authors of these sites are, in their own way, contributing to the history of television, and that the academic community should engage with them. Furthermore, he does not imply that all such sites are misleading; some of them, in their own style (and often tight focus) can be extremely thorough and useful for research. They range from matters of record, such as interview transcripts with important engineers (as preserved by learned bodies such as the IEEE), where the web is simply a modern method of dissemination, to sites with an agenda to preserve the memory of

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<sup>40</sup> Winston, *Media Technology and Society*, Chapter 5 Mechanically scanned television, and Chapter 6 Electronically scanned television.

<sup>41</sup> Briggs, *The Birth of Broadcasting*; Briggs, *The Golden Age of Wireless*.

<sup>42</sup> Briggs and Burke, *A Social History of the Media*, viii.

<sup>43</sup> Magoun, “Television History”.

<sup>44</sup> A site written and maintained by Baird’s son, Malcolm Baird: Baird, “Baird Television”; Barker, “Victor’s World of Television History”; Katz, “Allen Balcom Du Mont”; Elen, “Baird - the Birth of Television”.

a particular hero figure, which can still yield important clues to obscure resources and archive material.<sup>45</sup>

Accounts of the invention of television often turn towards pre-revolutionary Russia and Russian émigré scientist-engineers who played a leading role in the development of the technology. Understanding the origins of the actors and of their early research is helpful. Consciously or unconsciously, most works on the history of television technology have not fully taken into account the early work of pre-Revolutionary Russian scientists, or the significance of the work which continued in the Soviet Union and elsewhere in Eastern Europe in the 1920s and 1930s. Abramson's *Zworykin, Pioneer of Television*, is a detailed biography of émigré Russian scientist and leading RCA television engineer, Vladimir Kosima Zworykin, and it does add some useful social information about the 'scientific emigration' by Russians following the Russian revolution and civil war.<sup>46</sup> It is based on autobiographical notes which remained unpublished for many years because it was known that they contained many factual errors. Abramson expanded on the notes, as well as correcting the details, filling in some of the gaps and commenting on the context, revealing clues regarding Zworykin's relationship with Rosing and other Russian/Soviet scientists and engineers.

Scholarly work written by Western authors on television research and development in the Soviet Union is very scarce. The only work of relevance that I have discovered is a paper by Alexander Magoun, which looks at the diffusion of television technology by America to the Soviet Union in the late 1930s.<sup>47</sup> This illustrates the two-way nature of television development in the 1930s between United States and the USSR. On the one hand, there was emigration of Russian scientists, and on the other, the export of the actual technology back to the Soviet Union. Magoun seeks to examine why the American government and RCA should agree to this course of events given the poor relationship of the Soviet Union and the United States post-

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<sup>45</sup> Heyer and Pinsky, "Vladimir Zworykin"; Schatkin, "Farnovision"; Landen, "The Birth of Television"; Tihanyi, "The Iconoscope"; IEEE, "IEEE Global history Network".

<sup>46</sup> Abramson, *Zworykin*.

<sup>47</sup> Magoun, "Adding Sight to Sound".

Russian Revolution. In explaining this, he outlines the benefits to both countries in this transfer of advanced technology citing potential political and economic goals. For RCA, the industrial vendor of the technology, the value of the 'sale' was about 3 million US dollars, at a time (1937) when their profits were in decline. For the USSR, the acquisition of general electronic 'know-how' as well as television specific electronic engineering technology was invaluable in its drive to modernise in the 1930s.

A new opportunity is the possibility of incorporating narratives directly from the FSU (Former Soviet Union) countries, and I have endeavoured to find as many of these sources as practicable. Secondary sources on the invention of television from the FSU are only in the Russian language and have had almost no exposure in the West, yielding new information and perspectives. Only a full translation will yield a true impression, but for the purposes of this work only partial translations have been feasible. A biography of Boris Rosing, published in 1964, was written from a Soviet-centric view, at a time when the USSR was making many exaggerated claims for priority of invention and scientific discovery, but this in itself is illuminating.<sup>48</sup> Russian historian, V A Uralov, specialises in television history, both in terms of broad sweep approaches and biographies of Soviet television engineer/scientists. His co-authored biographies examine the work of important figures in the Soviet development of all-electronic television in the 1930s such as engineers Pavel Smakov, Boris V Krusser and Alexei V Dubinin.<sup>49</sup> There is also a recent biography of Rosing which adds new detail to his later work and life, as well as having an appendix of primary source material.<sup>50</sup>

Whilst the principal actors, such as Zworykin as the lead engineer in RCA's all-electronic television developments, are vitally important in any historical analysis of television, the individual members of the large and able teams have tended to be forgotten, and existing literature tends to be patchy in detail in this area. There are,

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<sup>48</sup> Gorokov, *B L Rosing*.

<sup>49</sup> Dunaevskaya, Klimin, and Uralov, *Boris Vasilyevich Krusser*; Dunaevskaya and Uralov, *Alexey V Dubinin*; Gogol and Uralov, *Pavel Vasilevic Smakov*.

<sup>50</sup> Kutsenko, *B L Rosing*.

however, full biographical works devoted to some development team members; an example of this is Robert Alexander's biography of EMI engineer Alan Dower Blumlein.<sup>51</sup> This book offers some insights into team motivation, internal politics, and transatlantic technical rivalry, but it does tend towards 'hero-worship' of its subject.

The rivalry in television development between companies and organisations in the United States, Britain and Germany has been examined by several authors, with broad coverage by Burns and D E and M J Fisher, but the interlocking collaborative nature of the companies is not addressed in any depth, and this is fertile ground in my search for associations.<sup>52</sup> It is in the development teams that the transnational nature of the development of all-electronic television can be observed. In the television laboratories of RCA in New Jersey, and in Britain at the newly formed partnership of Marconi-EMI, the team leaders were émigré Russians, and many of the leading team members were from Germany and France. The core technologies of all-electronic television can be traced to scientists, engineers and inventors from Britain, Russia, France and Hungary, and some sources do describe this complex and interlocked narrative, but without close attention to the networks which existed between them. Whilst the main development of the technology was by companies in the United States and Britain, industrial laboratories in Germany, Holland, Japan and the Soviet Union were all following almost parallel paths. British companies were particularly successful in rivalling (yet at the same time effectively collaborating with) the development programmes of American companies, a topic which I will explore in Chapter 5.

With regard to the existing literature covering the relationships of the companies and their people, several of the wide-ranging works do make some attempt to look at the inter-locking nature of the companies involved.<sup>53</sup> Burns is the most comprehensive in his coverage of the international aspects, and much information is present, but without connecting narratives in any linked, or networked form. Udelson sets out to

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<sup>51</sup> Alexander, *Alan Dower Blumlein*.

<sup>52</sup> Burns, *Television*; Fisher and Fisher, *Tube*.

<sup>53</sup> Burns, *Television*; Udelson, *Great Television Race*.



analyse the story of the American experience of the development of the television industry and the companies involved in what he refers to as the 'race'. Concentrating squarely on the United States as the setting for the 'race', he virtually ignores the close connections and interactions with European companies and broadcasters. Other literature which seeks to downplay the technology usually concentrates on the often long drawn out struggles of patent interlocutory, litigation and personal difficulties of a chosen principal actor. One such example is Daniel Stashower's *The Boy Genius and the Mogul*, which sets out to compare 'David and Goliath' in the battle between Philo Farnsworth and RCA, personified by its head, David Sarnoff.<sup>54</sup> Stashower's work, whilst rich in human interest and background, does treat Farnsworth as a hero. The idea of a David-and-Goliath struggle was mirrored in Britain with the corporate 'Goliath', played by Marconi-EMI and 'David' by John Logie Baird.

This simultaneous rivalry and co-operation of individuals, companies, industries and nations reverberates through to today in the often asked popular question 'who invented television?' Such a simple question will never be answered, as the interlocking relationships effectively reveal a multi-faceted transnational process. Nationalistic interpretations of the narrative probably explain the large number of web sites, books and television programmes that attempt to answer the question, or at least seeking to influence perceptions.

### **1.3 New primary sources**

The Royal Mail Archive in London has proved to be a major source of documentation relating to the broadcaster regulation activities of the GPO. It provides a valuable counter-point to the television histories of the BBC, and to the internalist histories of Electrical and Musical Industries (EMI) Ltd., and Marconi's Wireless Telegraph Co. (MWTC.) Ltd. Contemporary technical publications such as journals and magazines have also yielded valuable insights into the perception of the wireless trade and manufacturers of the rise of all-electronic television, as well as editorial and columnist comments on the political issues surrounding television's development. Government sources such as Cabinet Office papers and *Hansard* are

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<sup>54</sup> Stashower, *Boy Genius and the Mogul*.

disappointing with very few references of any kind to television pre-World War II. BBC sources from the Corporation's Written Archives Centre have been ransacked many times before, and most relevant references have been identified and referred to in the secondary literature. Archives such as The Alexander Graham Bell Family Papers at the Library of Congress, Washington, United States and the private archive of the Swinton family in Scotland have also produced previously unexamined material

Information which would probably clarify aspects of the relationship between the EMI and RCA is currently unavailable because the EMI archives are currently closed to researchers. This includes the bulk of the Marconi-EMI archives, leaving only the limited material available in the MWTCO. archive relating to the partnership. This is unfortunate, as the board minutes are known to exist and have never been examined for the early 1930s in the EMI archive. The RCA archive, via the Sarnoff Library, has useful correspondence between individuals at RCA, MWTCO. and EMI, although the quantity is not that great. Contemporary magazine articles, official company reports, technical journals and newspaper reports have all yielded useful insights and leads from an American perspective, and I have sought out as many sources as has been practicable.

Existing outside of the mainstream literature of the history of television are some unusually comprehensive bibliographic and primary source books. The bibliographic compilation work of engineer and historian George Shiers, is of special note.<sup>55</sup> Shiers collated some 9,000 entries from 1817 to 1940, producing the most comprehensive bibliographic source of television related material known. Less wide-ranging, but in deeper detail, is the source book works of Stephen Herbert, whose, *A History of Early Television*, presents reprints of newspaper articles, papers, book chapters and art-works connected to early the television history.<sup>56</sup> It is Herbert's collection, and it is thus inherently subjective with regard to the material selected, but it does present a large amount of contemporary primary documentation in its entirety. The

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<sup>55</sup> Shiers, *Bibliographic Guide*.

<sup>56</sup> Herbert, *Early Television*.

bibliographic work of Shiers is a useful check on the range of material found in this publication and by this method significant omissions can be identified.

Primary source material regarding ‘distant vision’ from the late nineteenth and early twentieth centuries in journals, periodicals and newspaper reports has been a very useful resource. Most of the surviving material has been known for many years, as documented in Shiers’ *Early Television - A Bibliographic Guide to 1940*, and in the extensive on-line work of Belgian media academic André Lange, in his *Histoire de la Television*.<sup>57</sup> By following leads from these sources, and from the broad sweep coverage secondary literature, I have found more primary material from periodicals and magazines such as the *Illustrated London News*, *Design and Work*, *Nature*, *Electrical Experimenter* and the *English Mechanic*. In addition to these, American and British newspaper such as *The Times*, *The Scotsman*, *The Boston Globe* and *The New York Sun* have all yielded useful material, as have specialist technical journals such as *Wireless World*, *The Electrician* and *Television*.

The development of all-electronic television in particular owes much to engineers and scientists from Russia, the Soviet Union and from Eastern Europe, but Western secondary literature on this tends to be repetitive and limited. Whilst Abramson uses Zworykin’s autobiographical notes relating to his upbringing and early career up to his emigration in 1919, he was limited in the availability of corroborating primary source material. Most of the other Western secondary literature has also concentrated on Zworykin, but it is now possible to research more deeply into Russian/Soviet television history, even to the extent of accessing obscure primary material. Sources from Russia in the first two decades of the twentieth century do exist in St Petersburg and Moscow archives, an example being the Museum of Communications in Saint Petersburg, but the documents are still difficult to work with in terms of physical access, translation and contextual understanding. Russian and Soviet Union patents are readily available from the Russian Patent Office Archive, and have yielded useful information about the technology of late 1920s and early 1930s all-electronic television.

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<sup>57</sup> Shiers, *Bibliographic Guide*; Lange, “Histoire de la Television”.

As a visual medium, television is about people seeing pictures and being able to engage with those pictures. The technology has to be good enough to convey the programme material without being marred by distracting impairments. For applications such as ‘telephone with pictures’, the required technical standard is lower than that required for broadcasting. The pictures can be smaller and are usually restricted to fixed head and shoulder portraits. For broadcasting, there was uncertainty in the 1930s about how good television had to be for people to be able to engage with it past its ‘novelty period’. Early cinema passed through a phase known to media historians as its ‘novelty period’, between about 1895 and 1898, when the technical capabilities of systems and the novelty of the cinema experience were paramount.<sup>58</sup> It is reasonable to assume that television systems went through a similar phase before its form and function as a new medium had been fully shaped and that this process would have taken several years. Extensive research work was undertaken by RCA in the 1930s to understand what constitutes a ‘good’ television picture and what would be acceptable in the home. This work was the first systematic analysis of television picture creation based upon research into human visual perception and the results were used by RCA to define the target technical specifications for their television systems.<sup>59</sup>

As there are very few still photographic pictures from television screens pre-World War II, let alone film footage, it is impossible to gauge the relative merits and problems of early television other than by reading contemporary accounts which are often contradictory. By using replicative technology, I have attempted to understand the strengths and weaknesses of the 1930s television systems. This is not a judgemental exercise: it is about understanding what the limitations of the various systems were, and how the RCA work in particular had informed choices about such standards according to the application envisaged. In particular, I have investigated the two British television formats of 1936, which existing literature invariably paints

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<sup>58</sup> de Klerk, “A Few Remaining Hours”, examines the ‘novelty period’ of cinema.

<sup>59</sup> R.C.A., *Television*. This collection of papers, published in 1936, as a volume recording the technical development of the company’s television research. It contains several papers relating to fundamental image characteristics, human perception and issues such as flicker and image resolution required for various applications of television and programme material.

as inevitably only having one possible winner, the Marconi-EMI system which was firmly based on RCA technology. The information regarding my technical recreations has been presented within an appendix and is offered as material evidence in support of my findings about inevitability and contingency in the development of television.

## ***1.4 Structure of the thesis***

Chapter 2, 'Dreams, ideas, hoaxes and practical solutions', concerns the origin of the desire to 'see at a distance', how it became a late nineteenth-century dream and intellectual challenge to inventors. I will first consider some of the possible origins for the idea of 'distant electric vision', 'far seeing', 'telectroscopy', or 'electrical telescopy', as the concept was variously known in the late nineteenth century. Folklore, legend, religion or early science fiction, are all possibilities for a stimulus to the concept of being able to see events instantaneously at a distance, but there is no compelling evidence of a dream of 'distant vision' across cultures and history.

The invention of the telephone (which could be described as 'distant hearing') is the real source of the complementary idea of instantaneous 'distant electric vision'. Inventors, engineers, writers, artists and the scientifically interested general public began to imagine a time when vision might be added to sound. The triggers for such dreams about 'distant electric vision' (as an adjunct to the telephone), were twofold: the almost concurrent discovery of the photo-electric properties of selenium, and the practical use of the phenomenon of the persistence of vision. By the late 1870s and 1880s, the practical realisation of the telephone was advancing rapidly, and it was proving to be relatively easy to reproduce technically and to exploit commercially. Was 'distant electric vision' going to be developed as easily as the telephone? Many attempts were made to harness late nineteenth century electro-mechanical technology to invent 'distant electric vision', but none were successful before the early 1920s. As the century drew to a close, the initial optimism of potential inventors of practical machines faded as the complexity of the problem became apparent.

Chapter 3, 'Spinning discs and revolving mirrors – the future of television is mechanical' will examine the brief era of electro-mechanical television; a very short-

lived period of popularity and investment in the technology. There is extensive secondary literature devoted to this period of television's history, but most of it is centred upon one actor: Scottish electrical engineer John Logie Baird. Rather than focus another study on this figure, I have elected to study three alternative case histories from the late 1920s and early 1930s. One is a virtually unknown American inventor, a direct contemporary of Baird, who achieved some success with the electro-mechanical television technology. The second case looks at the electro-mechanical television research of MWTCo., and its unsuccessful attempts to find niche commercial markets for it. The third case is an obscure British company called Scophony Ltd. The company plan was to develop large screen cinema television projectors based on a novel electro-optical technology which, whilst still electro-mechanical, was a radical departure from existing techniques.

Once electro-mechanical television had become a technical reality, commercial, consumer and governmental social shaping of the technology began in earnest, in response to the reality of informed technical criticism and user ('viewer') reactions to the inadequacies of such television. The short period of enthusiasm petered out over a few years, but essentially by early 1935 it was over and commercial attention was turning to 'high-definition' (relative to electro-mechanical), all-electronic systems, designed and developed in large, well-funded corporate development laboratories. But where and how did the original impetus for this new, all-electronic, technology come from? The next chapter seeks to answer this question.

In Chapter 4, 'Television with tubes: networks of dissemination', I will review the origins of all-electronic television and how the initially independent developments in pre-revolutionary Russia and Edwardian Britain became linked. I will describe how two almost concurrent proposals, by engineer A A Campbell Swinton and physicist B L Rosing, became the roots of all-electronic television research. The proposers were completely unconnected and neither was well-known beyond his specialisms. This was a genuine example of simultaneous invention. Pre-World War I, television, as subject for study and/or invention, was little discussed or investigated, the conclusion having been reached that it was just too difficult. The number of people involved in this 'quest' for 'distant electric vision' (or television as it increasingly became known after 1900), was tiny, perhaps no more than a few dozen individuals,

spread over many countries. This figure is not quantifiable, other than by patent applications, but there was certainly no corporate interest in the field, and activities were largely centred on a few scientists, engineers and inventors.<sup>60</sup> What is significant about these two figures is not the immediate impact of their ideas, but the influences which they imprinted upon people within their circles.

Campbell Swinton became convinced that his method was the correct one, becoming a vociferous critic in public, and in private, of the developing electro-mechanical techniques in the 1920s. In the case of Rosing, it is his influence on one of his students, Zworykin, which spread his belief in the use of cathode-ray tubes (CRTs) for television to a much wider audience in the United States in the early 1920s. It is also now known that Rosing continued to be associated with all-electronic television, advising researchers in at least one group in Uzbekistan working on all-electronic television in the late 1920s and early 1930s. As part of the narrative, I will explore the work of this almost unknown group in developing all-electronic television. With similar, but conceptually slightly different ideas to those of Zworykin, the narrative of invention in the Soviet Union compared to that in the United States is a novel aspect of my research.

I will also examine another likely follower of the Rosing/Campbell Swinton ideas: American inventor, Philo T Farnsworth, the subject of many internalist biographies and much speculation about his relationship with RCA and the associated patent interlocutory.<sup>61</sup> Whether his work and developments were predicated on those of Campbell Swinton is not certain, but the circumstantial evidence is strong. Existing literature emphasises the importance of Campbell Swinton's and Rosing's ideas in the light of developments in the 1930s, but I am focusing my attention on their networks of communication and influence, investigating the spread of their ideas via these mechanisms and how Campbell Swinton in particular was in the vanguard,

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<sup>60</sup> Shiers, "The Rise of Mechanical Television". On 511, Shiers used a histogram (Figure 1) to show the rise in world-wide 'television' patent applications from 1878 to 1930. There were 34 patents from 1901 to 1910, by 1922 it was 20 per year, and by 1930, 197 per year.

<sup>61</sup> Farnsworth biographies include: Schwartz, *Last Lone Inventor*; Godfrey, *Philo T Farnsworth*; Hofer, "Philo T Farnsworth"; Stashower, *Boy Genius and the Mogul*; Everson, *Philo T Farnsworth*.

both publically and privately, of the opposition to the deployment of electro-mechanical television in Britain.

In Chapter 5, 'International rivals and allies in the competition for television supremacy', I will study the rapid development of all-electronic television which mirrored other innovations of the 1930s, as corporations sought to invent their way out of the Great Depression. It is here that sizeable national and transnational networks really begin to form in earnest. The personal and corporate relationships of the principal companies such as RCA, MWTCO., EMI and BTL were extremely complicated, crossed national boundaries, exploited personal links and involved commercial ties forged in the early days of the wireless and gramophone industries. I will explore these relationships, what drew the companies and individuals together and examine how the corporate and personal linkages shaped the direction of all-electronic television development. My working assumption has been that RCA and EMI/Marconi-EMI shared a much closer technical and commercial relationship than has been presented in most of the British literature. This relationship was at the heart of the 1930s development of commercial all-electronic television and it exhibited two faces, one of co-operation and the other of rivalry. RCA was committed to 'wireless with pictures' and will show that the company's British associate, Marconi-EMI, was willingly led down the same avenue.

This already complex arrangement of corporate linkages was further complicated by the emergence of a new transatlantic group: an alliance rather than a formal partnership, of BTL and Farnsworth's Television Inc. This was a serious rival to the hegemony of the RCA/EMI/MWTCO grouping, but without the commercial power and governmental favour of its transatlantic rival, struggled to compete on its technological strength of the transmission of films via television. I will show that the world of television development in the mid-1930s was dominated by these two groupings, each with its own commercial imperatives. Both had to operate within the same regulatory systems for broadcasting and in the same commercial reality of the Great Depression, with the existing wireless industry hostile to an early introduction of high-definition television.



In Chapter 6, ‘Monopoly and rivalry in the race for high-definition television’, I will explore the initial deployments of television, focusing primarily on the British case, but noting that both sides of the Atlantic were inextricably linked by the commercial ties between RCA/Marconi-EMI, Farnsworth/BTL and to the German companies such as Telefunken. The major differences in approach to deployment were political and regulatory. In Britain, the Government and the GPO were keen to initiate a high-definition, all-electronic system as quickly as was possible. In the United States, the government and the FCC were more interested in technical standards and longer-term commercial opportunities than immediate deployment. In Germany there was a perceived opportunity to use television for propaganda purposes. I will explain why Britain was five years ahead of America in establishing a regular ‘high definition’ television service in 1936, and that this was in response to the ‘need’ to maintain and expand the BBC’s monopoly of broadcasting. The Corporation’s first Royal Charter expired in December 1936 and high-definition BBC television had to be in operation before that date in order to avoid awkward legal and political questions.

At the outset of my research, I believed that the British enthusiasm for launching a high-definition television service had a military imperative in the form of radar and other electronics based technologies needed CRTs, VHF radio and many other techniques to be found embedded in television, and this, I proposed, was a good way of developing the technologies needed. It is often civilians working with government bodies that have the foresight in new technologies for military use, and I believe that this could have been so in the case of television.<sup>62</sup> However, my research has failed to find any major influences, but it cannot be fully dismissed.

The opening of the British high-definition service, the ‘London Station’, was more than just a vehicle for the BBC to assert its monopoly: it was also an experiment in what television could become. The overt competition of the two technical television standards as developed by the competitors, Marconi-EMI and BTL, was one issue, but there was another aspect: whether BBC television would be mainly ‘live’ or ‘films to the home’. This has never explicitly been described, probably because the outcome of the technical trial which, in part, defined the model to be adopted, was

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<sup>62</sup> Rosen, “New Ways of War”.

virtually certain by the time of the opening. The ‘winner’, the Marconi-EMI system, favoured ‘live’ television, or ‘wireless with pictures’, a model which suited the BBC’s operating methods and tradition. BTL’s system was much better suited to televising pre-prepared film material, the ‘films to the home’ model of working. This strength was unsurprising, as by then BTL was owned by the Gaumont British Film Corporation, but which was forced to compete on the ‘wireless with pictures’ model. Most of the cinema industry, then at a commercial high-point, had not appreciated the potential impact of television. The conflict between the two media did not come to a head until the 1950s, when television gained full traction, particularly in the United States. I will show that the ‘London Station’ was important for many reasons, becoming the model for the operation of television services during television’s real boom years in the 1950s.

Campbell Swinton did not live to see the opening of the London Station, and he was wrong about it not being worth anybody’s while to develop it, although the profits did not really begin until the 1950s. What he was almost right about was the timescale and how it might be done. At the same 1924 lecture noted in my opening observation, he also said:

If we could only get one of the big research laboratories, like that of the GEC or of the Western Electric Co. – one of those people who have large skilled staffs and any amount of money to engage on the business – I believe they would make a reasonable job of it. I do not say it would be perfect, but they could get something worth having in six months quite easily.<sup>63</sup>

Campbell Swinton never made any suggestions about the use of television technology, but he implied correctly that it was a task best suited to a major wireless technology manufacturer. However, it would not be just one company because television development became a transnational project, with a web of national networks acting simultaneously as collaborators, yet rivals. As I will now demonstrate, Hughes is correct: invention is no respecter of boundaries.

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<sup>63</sup> Swinton, “The Possibilities of Television”, 118.

## Chapter 2

### ***Dreams, ideas, hoaxes and practical solutions: 1870-1920***

#### ***2.1 Introduction***

This chapter seeks to understand how the concept of ‘television’ appeared. From the late nineteenth century until the 1930s, when the word ‘television’ became common parlance, several expressions – ‘distant electric vision’, ‘distant vision’, ‘seeing by telegraph’, ‘seeing at a distance by electricity’, ‘electrical telescoping’ – were used to refer to fundamentally similar ideas of instantaneous moving image transmission.<sup>64</sup> How old is this concept? Has it always been with us and common across cultures, or is the notion comparatively new? It is tempting to assume that a desire to see further must be an ancient one, that spying on rival military forces, or simply checking up on an individual, has to have been common currency for centuries. This idea is sometimes implicitly presented in literature on the history of television.<sup>65</sup> The concept is then developed as a sequence of deterministic events gaining pace towards the fulfilment of that dream. There is no evidence for the idea of an ancient ‘dream’ of ‘distant vision’; but such a dream does occur later, beginning in the late 1870s, as an almost inevitable, logical, complement to the invention of ‘distant hearing’ – the telephone.

The early nineteenth century saw the rise of a requirement for faster communications across three interlocking spheres of activity - the operational needs of the railways, military objectives (in terms of logistics and battlefield advantage) and for global imperial civil administration and commerce. Existing methods of communication, such as the Chappe semaphore telegraph, could not begin to service such speed and volume requirements, resulting in the rise of the electric telegraph and the concept of

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<sup>64</sup> Swinton, “Distant Electric Vision”, *Nature*; Redmond, “Electric Telescope”; Carey, “Seeing by Electricity”; “Seeing at a Distance by Electricity”, *Journal of the Franklin Institute*; “Seeing to a distance by electricity”, *The Telegraphic Journal and Electrical Review*; Rosing, “Electrical Telescoping”; “Seeing by Telegraph”, *Colonist*; de Varigny, “La vision à distance”, *L'Illustration*.

<sup>65</sup> McLean, *Restoring Baird's Image*, 12-13; Burns, *Television*, 7-17; Lankes, “Historical Sketch of Television's Progress”, 233.

‘instant’ communication.<sup>66</sup> Such rapid signalling was taken further as a practical concept with the invention of the telephone, which developed rapidly alongside the existing telegraph, utilising much of the same infrastructure and techniques. If ‘distant hearing’ had been accomplished, what of ‘distant seeing’? Adding the complementary sense was a much harder task, but after the example of the telephone, it probably seemed plausible. There was, though, never a real contemporary need for such a capability; the requirements of governments, commerce and individuals for rapid communication were perfectly satisfied by the telegraph and the telephone – with such effective networks in place, what would a visual ‘accessory’ be for? In the late nineteenth century there was a limited desire to send and view written text, and also still pictures (facsimile) for newspapers and non-Roman script documents, but not for live, moving pictures.

Besides point-to-point communications, other potential uses might be envisaged for a ‘distant vision’ machine, but typically they would not rely on the method to be instantaneous in its action. Such a device then begins to look like a recording medium, which conceptually becomes motion pictures. If the qualifying condition of ‘instantaneous’ is applied to ‘distant vision’, a key differentiator between the two inventions emerges. With this qualifier applied, ‘distant vision’ remains tied much more closely to telegraphy, telephony and wireless telegraphy/telephony, as all are ‘instantaneous’ in their action. In what follows, I will concentrate on the development of technologies which support moving and instant (or near instant) visual communication, rather than that of motion pictures with its quite distinct narrative and roots, beginning, according to media historian, Brian Winston, with the projected image in the seventeenth century.<sup>67</sup>

In the first part of this chapter, I will review the evidence for instances of distant vision (and almost by default, also hearing) through recorded history, to identify potential sources of a precursor ‘dream’ which may have influenced the development of television. Before the late 1870s, such a search yields only vague myth, legend, folklore, religious belief, witchcraft, early science fiction and hallucinatory

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<sup>66</sup> Marsden and Smith, *Engineering Empires*, 187-192.

<sup>67</sup> Winston, *Technologies of Seeing*, 31-34.

experiences. Within these it is necessary to differentiate between ‘visions’ of past or future events, and those that might refer to ‘instant’ viewing of distant events. Once this definition is incorporated, there are surprisingly few examples of claims to distant seeing and/or hearing in antiquity. I will briefly examine one such instance of ‘distant vision’ from the early medieval period, which illustrates the limitations of the narratives which do exist.

The second part of this chapter will review three almost disconnected discoveries and inventions which dominate the early forces shaping ‘distant vision’, and these will be considered as thematic issues from the 1870s onwards, exploring their origins and their dissemination via newspapers and journals. These three stimuli, the invention of the telephone, the photo-electric properties of selenium and research into the persistence of vision, all contributed directly to the fundamental shaping of a ‘distant vision machine’.<sup>68</sup> A fourth, earlier influence, that of facsimile – the transmission over telegraph wires of text or drawings – also influenced practical proposals for ‘distant vision’ machines, but facsimile relates to still picture transmission where the ‘instantaneous’ condition is missing.<sup>69</sup> Such machines accomplished document transmission using the principle of scanning – breaking up a page of text or a drawing into a timed sequence of small parts – and the principle was incorporated into many proposals for distant vision.<sup>70</sup> These three stimuli, sometimes coupled to the earlier notion of scanning, and the speculative imaginings of artists and writers, fed into definite proposals about how to make a practical device. In the third part of this chapter I will describe the initial reaction of artists and writers to the

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<sup>68</sup> Photo-electric refers to any electrical response to incident light and can take several forms including photo-voltaic (generation of an electric potential), photo-emissive (expelling of electrons from a surface) and photo-conductive (a variation in resistance).

<sup>69</sup> Bain, “Electric Time-pieces and Telegraphs”, British Patent Office, No. 9745 Nov 27, 1843. A patent describing a machine for telegraphing written text, which was constructed and operated satisfactorily. Such machines used a scanning stylus at the transmitting end to explore a metal/insulator representation of the image, and a similar, synchronised, scanning stylus at the receiving end using an electro-chemical method to make marks on specially prepared paper.

<sup>70</sup> Other designs for facsimile machines appeared, such as one using cylindrical scanners in 1849, Bakewell, “Electric Telegraphs, British Patent Office”, Patent No. 12352, Jun 2, 1849 and those of L’Abbe Caselli (1862), Meyer (1869) and d’Arlingcourt (1872), see Burns, *Television*, 27-31.

concept of ‘distant vision’, and how their fanciful illustrations and writing fed back into real developments.

In the fourth part of this chapter I will describe how an identifiable dream about ‘distant vision’ does begin to appear, following the appearance of the three almost concurrent stimuli already described. This period of about three years, 1878-1881, witnessed interplay between speculative writing, hoaxes and genuine science which shaped the direction of the technical investigation and speculation. The dream was effectively shaped by the writings of scientists, engineers, inventors, journalists, artists and hucksters. I will illustrate the volatility of this process by describing a revealing misunderstanding regarding the name of an invention, the photophone, and the resulting publicity which was created. I will conclude this section by describing how this sea of ideas and speculation transitioned into possible practical ideas.

I will describe in the fifth part of this chapter some of the ideas which emerged in the last two decades of the nineteenth century – a relative period of inactivity in ‘distant vision’ research. Two out of the three proposals garnered almost no coverage in learned journals, magazines and newspapers, yet still appear to have become well known amongst other inventors. Conceptually, they were based on spinning discs, rotating drums and oscillating mirrors and all three used selenium as the photo-electric ‘transmitter’. This was also a period in which artists and writers began to fully engage with the concept of ‘distant vision’, and I will also examine their thoughts and expectations. In the sixth section I will describe one specific event in the narrative – the origin of the word ‘television’, and the conference where it first appeared in Paris in 1900.

In the final part of this chapter, I will consider the period 1900-1918, a time when a small number of inventors and scientists began much more detailed experimentation to realise a practical system based upon the earlier concepts, but with almost no industrial or university-based interest little was accomplished. Much of the early twentieth century work on television stemmed from developments in still picture telegraphy for image transmission, as used by newspapers and military applications, but there was still no clear commercial application for an ‘instantaneous’ television system. Despite this, a few inventors continued with their attempts to create a

workable system, sometimes presenting their efforts as ‘high speed facsimile’, in order to define a practical application. The fundamental technical issues to be addressed, in creating something approaching the ideas of the late nineteenth century artists and writers, revolved around achieving massive increases in speed and electro-optical sensitivity compared to still picture techniques. As of 1918, television, as a practical machine, seemed as far away from reality as it was in the 1880s.

In conclusion, I hope to show that television was not an ancient desire of mankind - there was no dream until the late 1870s - and when it did appear it was initially more to do with an abstract interest in the technology, rather than as an attempt to facilitate any application. I also aim to show that in the concentrated period of 1878-1881, a dream did begin to take shape, fuelled by the initial speculation and musings of writers and artists, framed primarily as a complement to ‘distant hearing’ – the telephone. I will show that the interplay of these strands had largely been through the agency of the late nineteenth century print media; in particular newspapers and periodicals, but also via learned journals. I will further conclude that thinking on ‘distant vision’ from the early 1880s, through to the turn of the century, was shaped largely by the waves of creative imagination from late nineteenth century lone inventor-enthusiasts, and not from scientists or engineers.

Although the year 1900 may seem like an artificially constructed watershed, especially with the birth of the word television, it does mark the end of the major hoaxes, unfounded optimism and a realisation of just how complex the problem of inventing television really was. The period leading up to the Great War, when the topic of ‘distant vision’ largely drifted away from the public gaze, was a period when television was regarded by most writers, inventors and scientists as being an impossible invention.

## **2.2 Roots of the ‘television’ concept**

### **2.2.1 ‘Visions’ through the ages**

There are not that many instances from fiction, or from historical records that could conceivably be presented as instantaneous ‘distant viewing’ before the late 1870s. Most examples of such visions are religious in origin, and involve divinities or their representatives revealing themselves to the faithful, often in a dream and usually describing a premonition or issuing commands. Such revelations are not examples of a concept of instantaneous ‘far seeing’ or ‘distant vision’. Some examples of ‘distant vision’ can be found in the process of scrying (crystal ball gazing), but these are normally visions of a past or future event. Limited, brief, examples of instantaneous ‘distant vision’ can be found in ancient texts and fiction right up until the mid-nineteenth century, usually invoking ‘magic mirrors’ of one form or another.<sup>71</sup> The earliest of examples of ‘magic mirrors’ in literature may well be Greek, such as that of Herodotus’ mirror, appearing later in Chaucer’s *The Squire in Wonderland* and later still in Goethe’s *Faust*. Similarly, belief in the properties of the ‘Third Eye’, or in clairvoyance, do not reference instantaneous ‘distant viewing’ as an aim or as an ability.<sup>72</sup> There are a few tales from the ancient world which may possibly imply instantaneous vision, such as one fictional narrative by Syrian writer Lucian of Samosata,<sup>73</sup> who wrote:

Another marvel I saw in the palace. There is a large mirror suspended over a well of no great depth; any one going down the well can hear every word spoken on our Earth; and if he looks at the mirror, he sees every city and nation as plainly as though he were standing close above each. The time I

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<sup>71</sup> Mak, “Chinese Magic Mirror Replica”, 102-107. Magic mirrors as featured in early literature are not the same as real, physical magic mirrors, or makyoh, of ancient Chinese and Japanese origin, which are still made today. These project an embedded image, which is not visible to the user of the mirror, up to distances of several hundred feet using sunlight as the light source.

<sup>72</sup> Schorske, “History and the Study of Culture”, 412; McCall, “The Squire in Wonderland”; Bub, “Vision and Revelation”.

<sup>73</sup> Pearce, “Lucian of Samosata”. Describes Lucian as a prolific satirical writer being born not long before 125 A.D.



was there, I surveyed my own people and the whole of my native country; whether they saw me also, I cannot say for certain.<sup>74</sup>

However, even though nineteenth century education was oriented towards the classics, it is unlikely that the works of Somosata would have had any influence upon thinking about ‘distant vision’. Somosata’s description is very non-specific, but there is a better, more clearly delineated example, of ‘seeing at a distance’ in a narrative relating to Saint Clare of Assisi.

### **2.2.2 Saint Clare’s vision of Mass**

In this example, the inference of instantaneous ‘distant viewing’ does exist in the narrative, setting it apart from other religious visions, and it appears to be unique. Saint Clare was the founder and head of a monastic order, the Poor Clares, in the late thirteenth century. As she lay on her death bed (Figure 2.1), on Christmas Eve in 1252, she was said to be disappointed that she could not attend the evening Mass being held some miles away. Witnesses tell of her claim to be able to see a vision on the wall of her cell of the events at the Mass, well beyond the range of human vision and hearing. Some of these accounts, used later as evidence for her beatification and canonisation, only recount her hearing the Mass, but at least one tells of her hearing and seeing it.<sup>75</sup> The next day she is said to have been able to describe people whom she saw and heard present at the Mass, ‘proving’ that her vision was genuine. Her canonisation was begun by Pope Innocent IV in 1253, and subsequently completed by Pope Alexander IV in 1255.<sup>76</sup> The process required many more instances of miracles, and her ‘seeing at a distance’ was only a part of the testimonies considered by the contemporary Papal authorities.

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<sup>74</sup> Lucian, *Lucian of Samosata*, 146.

<sup>75</sup> Armstrong, ed., *The Lady. Clare of Assisi: Early Documents*, 161-162, The Marvellous Hearing of Saint Clare; 230-231, XXV The Miraculous Consolation Christ Gave Her in Her Sickness; 306, A Certain Wonderful Consolation That the Lord Jesus Gave Her in Her Sickness.

All of these references describe the events of Saint Clare’s instantaneous vision of the Mass taking place several miles away. The accounts are from the witness statements taken during the process of canonisation and beatification.

<sup>76</sup> *Ibid.*, 139 and 262.

Saint Clare's vision, as documented in the near contemporaneous ecclesiastical accounts, was reason enough for Pope Pius XII to warrant installing her not only as the Patron Saint of Television, but also the Patron saint of the Telephone in 1958.<sup>77</sup> By the late 1950s, the medium of television was becoming ever more powerful, and the Catholic Church had found an ancient relevance to contemporary life, and arguably a powerful one. Pope Pius XII noted in an Apostolic brief in 1958:

But television -- besides the common element which it shares with the other two means [radio and cinema] of spreading information about which We have already spoken -- has a power and efficacy of its own.<sup>78</sup>

These words were written at a time when the Catholic Church was trying to establish a response to the modern world, using its own history and teachings to help define it. The narrative was used to support the fading ideas of Neo-Scholasticism, which were finally discredited by the Second Vatican Council begun in 1962.<sup>79</sup> In linking Saint Clare with television, the twentieth century scholars of the Catholic Church appear to have given considerable weight to the significance and relevance of her vision.

There is no evidence that Saint Clare's vision remained anything other than a little known ecclesiastical narrative until after the actual widespread deployment of television in the twentieth century. The unique story of Saint Clare, with its precise idea of instantaneous vision (and sound), does not surface again in such a specific form until the last quarter of the nineteenth century. The 'dream' of 'distant vision', if ever there was one, really belongs to the 1870s, following the rise of high speed communications. I will now turn towards the stimuli which shaped thinking about 'distant vision' in the nineteenth century, triggering what might be termed the 'real' dream era of 'distant vision'.

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<sup>77</sup> Apostolic letter, *Lettre Apostolique Proclamant Ste Claire Patronne Céleste De La Télévision* [Apostolic Letter Proclaiming St. Clare Patron of Celestial Television], 17 Feb. 1958.

<sup>78</sup> Apostolic brief (1957) *Miranda Prorsus*, Encyclical of Pope Pius XII on the Communications Field: Motion Pictures, Radio, Television Sep 8, 1957, para. 152.

<sup>79</sup> Daly, "Catholicism and Modernity", 793.

### **2.3 An invention, a discovery and a study**

Of the three stimuli that I have proposed as being the most significant triggers in the origin of ‘distant vision’, telephony (distant hearing) is the most important, being a directly related concept in transferring one human sense to a distance. The other two, photo-electricity and persistence of vision, are secondary to the establishment of the concept of instantaneous sensual communications, but they are more than just catalysts. The invention of the telephone was only a few years before the appearance of ideas of ‘distant vision’. Given the huge publicity surrounding the invention, it is reasonable to suppose that it was that which triggered the notion of being able to instantaneously see at a distance as well as to hear – an ‘electric eye’ to go with an ‘electric ear’. This was, after all, the beginning of the period that has been described as a ‘gigantic tidal wave of human ingenuity’ and such bold ideas were emerging with great rapidity.<sup>80</sup>

Triggered by the discovery of the photo-electric properties of selenium, a slew of concepts appeared in the late 1870s of how to achieve for the sense of vision what the telephone did for the sense of hearing. Telephone pioneer Alexander Graham Bell inadvertently provided a further stimulus, encouraging further investigations, with his proposal for a wireless telephone, which he named the ‘photophone’ suggesting some connection with photography rather than simply ‘light’, which was the intended association. This was the age of the independent inventor, and the so-called ‘Edison Method’; the successful ‘hunt and try’ approach, which was delivering new creations, seemingly every few years.<sup>81</sup> With such examples as the telephone and electric light, ‘distant vision’ could have appeared to inventors as just one more achievable invention.

The development of photography in the 1840s (a still picture taking system), might appear to be logically related in some way to the invention of television (a picture transmission system). The same could be assumed of motion pictures. However, although they are all visual media, there are actually very few direct linkages

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<sup>80</sup> Hughes, *American Genesis*, 13.

<sup>81</sup> *Ibid.*, 181.

between television and photography/cinematography. Whilst both have an important part to play in terms of offering supporting technologies such as suitable lenses and precision opto-mechanical assemblies, neither was a pre-requisite for the invention of television. This applies not only to the technology, but also to the factors leading to the desire to develop and shape it as interest in photography, and subsequently motion pictures, increased. Only the work on the persistence of vision has a clear and unambiguous overlap between 'distant vision' and motion pictures. I will now review the three stimuli that I have proposed as being the most significant influences, explore why they are important, and describe how the information about each was disseminated, beginning with the invention of the telephone.

### **2.3.1 The rise of telephony and its public perception**

By the late 1860s, telegraphy was a technology in daily use in the lives of many citizens of the United States, and also of the European colonial powers, rapidly spreading the reach of the network to far-flung outposts of their empires. Whether in the service of the military, government administration, commerce or for purely private messaging, telegraphy was an established and valuable communications network linking communities across the globe. With its roots in land based semaphore taken to new levels of speed, the instantaneous nature of the technology was a useful new characteristic in communications, but not vital for most messaging other than when used for railway signalling and urgent military applications. By the early 1870s, it was a rapidly growing major new industry with over 650,000 miles of wire, 30,000 miles of submarine cable and connecting more than 20,000 towns and villages.<sup>82</sup> By 1880 the world-wide submarine cable network had grown to almost 100,000 miles, linking almost every major city and colonial settlement in the world.<sup>83</sup> As a communications system it was unrivalled in its speed and ability to handle large traffic volumes, but it needed intermediaries - large numbers of specialist operators in the form of telegraphists - who had to be proficient in reading and sending the various forms of coding, especially in that of Samuel Morse. In most respects this suited the telegraph companies as they could charge a premium for their services,

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<sup>82</sup> Standage, *Victorian Internet*, 97.

<sup>83</sup> Ibid.

enabling them to build the expensive telegraph systems at home and abroad and operate them at a profit.

As the networks grew, a desire was identified to be able to re-use existing cable runs for more than one communication channel, a technique known as ‘multiple working’. By the mid-1870s techniques to achieve this had been developed, and cable networks could effectively carry twice or even four times as much traffic without adding any more physical wire.<sup>84</sup> Inventors were looking for methods to further multiply the capacity of a given network, and the favourite potential technique was that of the harmonic telegraph using tuned musical instrument reeds to create multiple channels of tones down a single wire. This line of experimentation, coupled with a conceptual leap, produced multiple inventions of the telephone. Popularly attributed to Bell, following his first public demonstration in 1876, the narrative of the invention of the telephone is well-known. This was the first globally publicised example of instantaneous ‘remote hearing’, and compared to the very short range taut wire acoustic telephone or the speaking tube, was capable of working over extremely long distances. The principle of direct instantaneous communication, using plain speech and normal hearing over long distances, was a significant philosophical shift in communications technology. The reaction in newspapers and periodicals was rapid, producing headline coverage across the world.<sup>85</sup>

### **2.3.2 The discovery of photo-electricity**

The discovery of photo-electricity in the form of photo-conductivity, the change in electrical conductivity, was made accidentally in 1873 in relation to the properties of the element selenium and its potential use in testing telegraphic cables. With the level of growth in the number of telegraph installations, the expertise to design

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<sup>84</sup> Hughes, *American Genesis*, 56.

Loring, *The Electro-magnetic Telegraph*, 62.

<sup>85</sup> “Notes on Science”, *South Australian Register*, 1876; “Stentor Distanced”, *The Times*, 1877; “Articulating Telephone”; “The Telephone”, *Boston Daily Advertiser*, 1876. Sub-headline reads: ‘Another Successful Experiment with This Remarkable Discovery - Audible Speech Conveyed Nearly Two Hundred Miles by Wire’.

effective systems also had to develop to keep pace, fostering the establishment of organisations such as the Society of Telegraph Engineers in 1871. As both a professional association and a learned society, marking the rise of telegraph engineering professionals, it became a focus of telegraph expertise.<sup>86</sup> Much of its members' early work was concerned with measuring techniques and standards, and one leading engineer in this specialism was Willoughby Smith of the Telegraph Construction and Maintenance Company Ltd. Smith, whilst working on cable insulation testing, had perfected a new method of being able to carry out resistance measurements whilst the cable was being laid, and yet still being able to simultaneously communicate with the shore.<sup>87</sup> The method required a precise high value resistor to terminate the cable at the shore end used in conjunction with a sensitive Wheatstone bridge or differential galvanometer system.<sup>88</sup> Smith began experimenting with the element selenium in its crystalline form to make such a high value reference resistor. Tests produced inconclusive results; the order of magnitude of the resistance was essentially satisfactory for the purpose, but it was varying for no known reason. Smith and his assistant, Joseph May, eventually deduced that it was the action of light on the sample which was causing the problem – the resistance decreased when the selenium was exposed to light.

Smith wrote a letter to fellow telegraph engineer Josiah Latimer Clark, supplying to him the bare details of his discovery and requesting that he reveal the discovery at the next meeting of the Society of Telegraph Engineers in London on February 1873.<sup>89</sup> Reports of the disclosure by Clark on Smith's behalf appeared in both *Nature* and *Scientific American*,<sup>90</sup> and in summary form in the British national press, with

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<sup>86</sup> Marsden and Smith, *Engineering Empires*, 219.

<sup>87</sup> Thomson, "Short Atlantic Telegraph Cable", 20.

<sup>88</sup> The Wheatstone bridge was named for British scientist and inventor, Sir Charles Wheatstone, although originally invented by British mathematician and scientist Samuel Hunter Christie. It consists of two networks of balancing resistances, or ratio arms, brought into balance by using a sensitive galvanometer.

<sup>89</sup> Smith, Feb 4 1873. Letter to Latimer Clark.

<sup>90</sup> Smith, "Effect of Light on Selenium During the Passage of an Electric Current", 303; Smith, "Curious effect of Light on Selenium", *Scientific American*.

Clark's speculation as to what the discovery might be used for also reported.<sup>91</sup> The suggested use was modest – a possible method useful in photometry – the measurement of light intensity.<sup>92</sup>

A much more comprehensive paper with full results of experiments and experimental techniques appeared four years later in 1877.<sup>93</sup> This work, headed by W G Adams, Professor of mathematics at the King's College in London, may have been in response to scepticism about Smith's claims for the properties of selenium. The detailed and analytical paper provided precise measurements of resistance values for selenium under numerous variable conditions such as the wavelength of the illuminating light, ambient temperature, excitation voltage, exposure time, excitation polarity and illumination intensity. Using some of the same physical samples as Smith, these thoroughly described findings comprehensively verified his results, validating his original assertions about selenium's electro-optical properties and removing any further scepticism. The detailed descriptions of measurement techniques and tables of results in the paper showed that the effect is pronounced; large changes in resistance occur with relatively small changes in illumination. The paper also noted the slowness of the effect – a fairly rapid response to an increase in illumination, but a very slow response to a reduction in the intensity. There were no further immediate applications proposed for the effect, not even for photometry.

### **2.3.3 Persistence of vision**

The third major stimulus to the invention of a 'distant vision' machine is shared by the early history of motion pictures, and it is the discovery and understanding of human vision physiology relating to the persistence of vision. The concept of displaying moving images by using a rapid succession of pictures became well known in the nineteenth century in the form of child's toys, laboratory devices and in magic lantern shows, but the most well-known example is the use of sequenced photography by British inventor Eadweard Muybridge. He famously used the technology in 1877 to capture animated horse pictures to win a bet to prove that all

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<sup>91</sup> "Selenium", *The Times*, 1873.

<sup>92</sup> Ibid.

<sup>93</sup> Adams and Day, "Action of Light on Selenium", 313-349.

the legs of a horse leave the ground when in a gallop.<sup>94</sup> Muybridge's subsequent work on sequential photography became famous via his frequent writings in popular periodicals and lectures, both in the United States and in Britain.

The human eye/brain response to movement leading to the perception of an after image, usually known as the persistence of vision, is a recurring discovery and invention. It was described by Roman poet Lucretius, noted by Ptolemy and Leonardo da Vinci, and demonstrated by Chinese inventor Ting Huan around 180 AD.<sup>95</sup> It reappears in the nineteenth century in the form of the thaumatrope, a spinning disc toy invented by Cornish Physician Dr John Ayrton Paris in 1825, and in other toys based on spinning wires.<sup>96</sup> A later example, the daedalum, developed by British mathematician William George Horner in 1834,<sup>97</sup> appeared throughout the nineteenth century with a range of fanciful names.<sup>98</sup> One such variant, the zoetrope, invented by American developer William F Lincoln in the 1860s, achieved huge popular success, introducing the concept of persistence of vision to hundreds of thousands of purchasers.<sup>99</sup> There were many further variants, but one, that of chronophotography, developed by French inventor and photographer, Étienne-Jules Marey, enabled studies of photographed subjects such as the motion of birds in flight.<sup>100</sup>

Beyond the initial novelty and public spectacle, American scientist Edward Nichols began investigations into the detailed scientific properties of the phenomenon, quantifying persistence against variables such as wavelength and light intensity in

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<sup>94</sup> "The Actual Movement of Horses", *New York Times*, 1878.

<sup>95</sup> Needham, *Science and civilisation in China*, 122-125.

<sup>96</sup> Brewster, "Contributions to popular science", 87.

<sup>97</sup> Coe, *History of movie photography*, 32.

<sup>98</sup> For example, the phenakistoscope of 1832, is described in: Plateau, "Sur un nouveau genre d'illusions d'optique", the choreutoscope, of 1866 in: Turner, *Nineteenth-century scientific instruments*, the fantascop of 1830 in: "Ackermann and Co.'s Fantascop", *The London literary gazette and journal of belles lettres, arts, sciences, etc for the year 1833*, the kaleidorama of 1875 in: Ferris and School, "Improvement in Kaleidoramas", United States Patent Office, Patent No. 163,173.

<sup>99</sup> Hertz, L H, *The handbook of old American toys*, 102.

<sup>100</sup> Marey, "Photography of Moving Objects".



1884.<sup>101</sup> Late nineteenth century work examined this theme further,<sup>102</sup> and practical cinematograph experiments towards the end of the century confirmed that to achieve reasonable levels of fluidity of motion and acceptable flicker, at least sixteen pictures per second were needed.<sup>103</sup> This figure effectively set the speed requirement for any future ‘distant vision’ system to achieve believable motion. The newspaper publicity surrounding Muybridge’s work in particular was widespread, not only triggering many further investigations and inventions concerned with moving images, but introducing the idea of moving pictures to a wider public.<sup>104</sup>

## **2.4 Adding sight to sound – hoaxes, inventions and speculation, 1878-1881**

In this period, speculation, some based upon reasonable conjecture, and some on baseless guessing, developed by discussion through the medium of magazines, periodicals and newspapers. Such speculation was occasionally taken to extreme levels by scientific hoaxers: those individuals wilfully deceiving the public, whether simply for purposes of amusement, attention seeking or financial gain. Contemporary artists and writers were also stimulated by such discussions about ‘distant seeing’ machines, whether triggered by hoax, or by legitimate speculation. Such responses then fed back into the scientific discussions, further shaping developments and speculation. Ultimately, the notion became likely material for the nascent new genre of science fiction, based on informed speculation, further fuelling public exposure to the concept.

Between 1878 and 1881, the concept of seeing at a distance received publicity in leading popular publications such as *Punch*, in newspapers on both sides of the

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<sup>101</sup> Nichols, “On the Duration of Color”.

<sup>102</sup> Ferry, “Persistence of Vision”.

<sup>103</sup> Edison, “Kinetographic Camera”, Patent No. 403,584.

Flicker perception and fluidity of motion are related, but not the same. Flicker perception depends greatly upon luminance and viewing angle. Modern film uses 24 frames per second, but repeated.

<sup>104</sup> Kingston University, London, <http://www.eadweardmuybridge.co.uk/> Accessed 01/24/2011, holds a database of Muybridge materials with many press articles and photographs. Examples of newspaper articles: “A Trotting Horse”, *The Times*, 1877; “Mr Muybridge”, *Lowell Daily Citizen*, 1877.

Atlantic and in academic journals. A hoax invention in an American newspaper called the telectroscope, a real invention called the photophone (a light beam telephone), a speculative cartoon about long-distance sight/sound communication, publicity surrounding Muybridge's work and reports about the photo-electric properties of selenium, all fed into this rapidly moving swirl of ideas, with artists and writers feeding off of each other, further intensifying the pace. By 1880, ideas had reached an initial speculative height, and attempts to realise an actual practical system had also begun to appear.

### 2.4.1 Hoaxes and speculation

The first hoax recorded about 'distant vision' originated in a letter entitled 'The Electroscope' which appeared in the *New York Sun* newspaper on March 29<sup>th</sup> 1877. The scientific sounding name was actually already in use to describe two types of electrical charge indicator, the pith ball electroscope (1754)<sup>105</sup> and the gold leaf electroscope (1787).<sup>106</sup> The letter made extravagant claims about a 'seeing at a distance machine', supposedly soon to be revealed to the public.<sup>107</sup> The date, two days before 'April the First', has led the discoverer of the letter, Belgian media historian André Lange, to suggest the annual ritual of such newspaper pranks as the reason for publication.<sup>108</sup> Whatever the source or stimulus for this letter, it is a significant piece of prophecy about the uses and construction of a 'seeing at a distance machine'. It is the earliest known detailed writing on the subject.

The letter, signed only as 'Electrician', describes a multitude of wires between the transmitter and receiving ends, each consisting of an empty room or box with an active wall. The transmitting end features special wire ends which respond to the colour and intensity of light incident upon them and at the receiving end a 'newly discovered gas, a sort of magnetic-electric ether in which the currents of light become resplendent again'.<sup>109</sup> How widely read this letter was is impossible to

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<sup>105</sup> Herbert, "John Canton", 128.

<sup>106</sup> Elliott, "Abraham Bennet", 6.

<sup>107</sup> 'Electrician'(Anon.), "The Electroscope".

<sup>108</sup> Lange, "L'histoire de la television commence par un canular".

<sup>109</sup> 'Electrician'(Anon.), "The Electroscope".

estimate, but a cutting of it survives in the archives of Edison's Menlo Park laboratories, as collected by his principal assistant, Charles Batchelor.<sup>110</sup>

The name of the 'invention' in the letter, the 'electroscope', is also very close to another subsequent article in a Boston (United States) newspaper, published the following year, about the 'telectroscope'. This report, about French author Louis Figuier's annual review of science and industry, mentions another 'seeing at a distance' machine.<sup>111</sup> This account credits the inventor of the telephone, Bell, with the invention, but suggests: 'but we must wait for accurate descriptions of the aircraft to believe this announcement'.<sup>112</sup> By 'aircraft' (a literal translation from the French), the author is signalling improbability, perhaps 'flying a kite'.

Another speculative distant viewing system, one credited to Edison, was depicted in a George du Maurier cartoon in the pages of the *Punch Almanack* for 1879, drawn in late 1878 showing a fanciful telephone conversation accompanied by a large screen view of the remote scene (see Figure 2.2). The communication is clearly meant to be instantaneous, as evidenced by the two way nature of the fanciful communication between a father in England and his daughter in Ceylon. The device is referred to as 'Edison's Telephonoscope', reflecting Edison's already strong reputation for fantastic new ideas, but the caption also describes it as being an 'electric camera-obscura', another recurring description applied to 'distant seeing' machines throughout the 1880s.

## 2.4.2 The photophone – a case of mistaken invention

Towards the very end of the 1870s a potential major application for the photo-electric properties of selenium did emerge: the 'photophone' - a way of 'speaking on a light beam' - impressing speech modulation on to light. Unfortunately the name was misleading, possibly implying 'distant vision', rather than telephony by light,

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<sup>110</sup> The Thomas Edison Papers, [MBSB1] Special Collections Series, Charles Batchelor Collection, Scrapbooks: Cat. 1240 (1876-1878) New York. Mar 29 1877 *New York Sun*, Clippings; "The Electroscope"

<sup>111</sup> Figuier, *Year Book*, 1878.

<sup>112</sup> Ibid.

and to compound the confusion, its public introduction was drawn out, with only fragments of the story emerging in the press. The name in itself became a stimulus to ‘distant vision’ invention, and coupled to the famous name of Bell it received wide publicity. The photophone was first publically demonstrated in 1880, and the misconception concerning the name not only prompted thoughts about distant vision, but raised further interest in the properties of selenium generally.<sup>113</sup> The invention was a novel use for the photo-electric properties of selenium, and in its practical form was relatively simple to construct, but limited in its communication range.

The invention consisted of two principal parts, a sending apparatus and a receiver (see Figure 3). The sender utilised sunlight focussed on to a thin mirror which varied from concave to convex in response to the air pressure variations caused by speaking into it. This produced amplitude modulation of the light in response to the speaker’s voice. The resulting modulated light beam was concentrated and aimed at a distant receiving parabolic mirror having a piece of crystalline selenium at its focus. The electrical resistance of the selenium varied in sympathy with the strength of the modulated light beam, and by connecting a telephone receiver in series with it and with a battery, the speaker’s voice was reproduced.

The device was limited in its possible applications – it needed sunlight to work and had a limited range of about 200 yards – but it did work. Unfortunately for Bell there was no take-up; the invention found no real niche and rapidly faded from public consciousness, despite Bell declaring it be ‘the greatest invention [I have] ever made, greater than the telephone’.<sup>114</sup> It was not the invention itself but the confused initial publicity implying a distant viewing machine coming from such a respected source as Bell, which had a lasting impact, shaping the development of telecommunications

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<sup>113</sup> Abramson, *The History of Television*, 14.

<sup>114</sup> Many secondary sources cite this quotation. See: Burns, *Television*, 55; Bruce, *Alexander Graham Bell*, 343 and Rowland, *Spirit of the web*, 213. Most refer to the source as an interview with a journalist for a telephone company house magazine in 1921 which is unavailable, but a later article by the journalist about the interview does not mention the point. See: Martin, “An interview with Alexander Graham Bell”. Other secondary sources point to a lecture in the United States in 1898, but no further details have come to light.

in an unintended way. I will now examine the narrative in more detail, focusing on the publicity and misconceptions.

Bell's telephone still needed cables to connect it to the telegraph/telephone network and had potentially exacerbated the problem with cable costs which had been one of the stimuli leading to its invention – a telephone needed a dedicated line. The photophone was an attempt to eradicate the need for telegraph/telephone lines completely. The core idea may have originated with a letter, signed only as 'JFW, Kew', to *Nature* in June 1878 (probably Johann F Wilke, a Dutch botanist, then working at Kew Gardens), suggesting:

Till now I have looked in vain for any account in NATURE of experiments with the telephone or phonoscope, inserted in the circuit of a selenium (galvanic) element (see NATURE, vol. xvii, p. 312).

One is inclined to think that by exposing the selenium to light, the intensity of which is subject to rapid changes, sound may be produced in the phonoscope. Probably by making use of selenium, instead of the tube-transmitter with charcoal &c., of Prof. Hughes, and by exposing it to light as above, the same result may be obtained.<sup>115</sup>

The description is confused, as the phonoscope referred to is a sound pick-up device - a microphone - and the system being intimated requires a sound receiver, not a transmitter.<sup>116</sup> Notwithstanding this misunderstanding, the idea of a 'light beam telephone' is fairly clear.

The essential ideas underpinning Bell's photophone were not his own, as in a paper read before the American Association for the Advancement of Science in Boston on August 27, 1880, he freely attests to the fact that the anonymous 'JFW', along with a confidential correspondent from London, a Mr A C Brown and a Mr W D Sargent of

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<sup>115</sup> "Telephone", *Nature*.

<sup>116</sup> Hughes, "On the Action of Sonorous Vibrations", 362 explains that the phonoscope is a sound detector – a microphone.

Philadelphia, had all anticipated his invention.<sup>117</sup> The origin of the idea apart, it is the development, the patenting process and the surrounding publicity of the photophone which helped to encourage the belief that it was some form of distant viewing machine. That process begins in Boston (United States America), in 1878 with experiments being carried out by Bell on the newly discovered photo-electric properties of selenium. In his speech to the Royal Institution in May 1878, he says of this work:

If you insert selenium in the telephone battery and throw light upon it, you change its resistance and vary the strength of the current you have sent to the telephone, so that you can hear a shadow.<sup>118</sup>

This report is quite clear, showing no other purpose or intention other than explaining a curiosity, and there is no mention of the name ‘photophone’.

Bell returned to the United States in November 1878, and soon after engaged the services of a young scientific instrument maker, Charles Sumner Tainter, to assist him with his work.<sup>119</sup> At what point the name ‘photophone’ was coined, or by whom, is unknown, but the concept of a ‘wireless telephone’ is certainly documented by early 1879.<sup>120</sup> Bell and Tainter had to overcome the problem of how to make a sufficiently powerful transmission to excite the insensitive and sluggish selenium to drive a standard telephone receiver. In addition, the very high resistance of the selenium had to somehow drive the fundamentally low resistance standard telephone receiver. The first successful demonstration of the overall principle was in February 1880, utilising a double grating modulator at the sending end. In such a system, sunlight is directed on to a grating ruled on a silver coated glass plate attached to a diaphragm, with the light passing to a second similar grating placed a few millimetres away. The voice of someone speaking near the diaphragm caused the

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<sup>117</sup> Bell, “Sound by Light”.

<sup>118</sup> Hutt, Snell, and Bélanger, “Graham Bell's Photophone”, 22.

<sup>119</sup> *Ibid.*, 22.

<sup>120</sup> Bell, 1879. In a letter from Bell to his wife, he mentions difficulties with the ‘photophone’, but still believes in ‘the feasibility of talking by light’.

first grating to vibrate, which in turn allows light to pass or be blocked depending upon the relative alignment of the gratings. The problem of the resistance of the selenium was solved by effectively connecting in parallel many selenium cells in a concentric ring arrangement. With a roughly working prototype, albeit only on the laboratory bench, Bell then quickly demonstrated the system to a witness and had the details filed in a sealed box and then deposited at the Smithsonian Institution. Tainter then turned to increasing the range of the instrument by devising a new method of modulation using a thin silvered mirror alternately swinging from concave to convex, illustrated in Figure 2.2 (top), and to increase the sensitivity of the receiver a large parabolic silvered bowl with the selenium cell set at its focus was employed, also shown Figure 2.2 (bottom). The increase in range was dramatic, with 213 metres being achieved by June 1880.<sup>121</sup>

Rumours about the invention had begun to leak to the press, and stories about depositing a machine with the Smithsonian fuelled speculation about the nature of the ‘photophone’, even in the respected journal *Nature*.<sup>122</sup> Bell was sufficiently confident of his position, both technically and commercially with regard to future patent protection, that he could announce his new invention publically. This was done by delivering a speech describing the photophone to the American Association for the Advancement of Science on August 27<sup>th</sup> 1880. The next day, a full patent application was lodged, completely describing the photophone invention.<sup>123</sup> Publicity in the national and international press followed rapidly on the strength of the inventor’s name, and in the main this was clear and unambiguous, but some reports still failed to appreciate that it was a ‘wireless telephone’, not a distant viewing machine.<sup>124</sup> The confusion was understandable, not just given the name of the

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<sup>121</sup> Bell, “Sound by Light”.

<sup>122</sup> “Physical Notes”, *Nature*. Describes speculations about what Bell’s new invention actually was. Also see photophone newspaper rumour in *Boston Evening Transcript*, Feb 20 1880.

<sup>123</sup> Bell, “Apparatus for Signalling and Communicating, Called ‘Photophone’”, Patent No. 235,199.

<sup>124</sup> Middleton, “Seeing by Telegraph”. In this letter to the editor of *The Times*, British scientists Ayrton and Perry assumed that the Bell invention was a distant seeing machine, and then attempt to establish their own claim for priority on such a scheme.

invention, but also because of a hoax invention assigned to Bell in 1878 which I described in Section 2.4.1 of this chapter.

### **2.4.3 Real proposals for a ‘distant vision’ machine, 1878-1881**

In parallel with the imaginative and speculative activities of writers and artists based upon sketchy extrapolations from the three stimuli already described, there was an increasing interest by scientists, inventors and engineers about how such a concept of ‘distant vision’ might be achieved in practice. In an era where precision mechanical engineering allied to electricity was regularly producing new inventions, it is not surprising that attempts to invent ‘distant vision’ largely relied upon a hybrid of electrical and mechanical technology. However, most of the first ideas appearing in the closing years of the 1870s and the early 1880s suggested all-electrical methods based upon a matrix of light sensitive elements, each connected by individual wires to a corresponding matrix of lights.

Later, into the 1880s, scanning systems utilising electro-mechanical mechanisms appeared in an attempt to reduce the number of inter-connecting wires with the ultimate goal of needing only one wire – assuming an earth return as commonly used in telegraph and telephone practice at the time. All of these proposals depended upon the photo-electrical properties of selenium, already disseminated via the international distribution of journals, pamphlets, periodicals and newspapers. I will now examine some of these proposals and how reports and papers about them fed into a small global community of inventors and scientists.

The first known scientific treatise on ideas for ‘distant vision’ came from a Portuguese scientist, Professor Adriano de Paiva, of the Polytechnic Academy of Porto. His treatise, “A telefonia, a telegrafia e a telescopia [Telephony, telegraphy and telescoping]”, was published in March 1878 in Portuguese.<sup>125</sup> It was subsequently translated into English by one of de Paiva’s students, William Macdonald Smith in 1880.<sup>126</sup> The translation was part of a package of documents

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<sup>125</sup> de Paiva, “A telefonia, a telegrafia e a telescopia”.

<sup>126</sup> Lange, Previous ref., translated by William Macdonald Smith,  
[http://histv2.free.fr/de\\_paiva/telescopie11.htm](http://histv2.free.fr/de_paiva/telescopie11.htm), Accessed: 05/27/2010.



assembled by de Paiva which included a fresh paper which also appeared in French.<sup>127</sup> According to Lange, the purpose of this second tranche of publication was an attempt by de Paiva to establish priority for his work in the light of the appearance of new proposals.<sup>128</sup> Given that de Paiva had been writing to *La Nature*, attempting to build on his initial suggestions, it is quite likely to have been so.<sup>129</sup> De Paiva's ideas were inspired by demonstrations of the telephone and of the reports surrounding the Telectroscope.<sup>130</sup> He offers nothing with regard to any practical techniques of how his 'electric telescope' might be constructed, other than the use of selenium to facilitate the pick-up part of the system.

Another scientist/inventor whose name recurs in the periodicals, pamphlets and newspapers of the late 1870s and early 1880s, is French scientist Constantine Senlecq. His proposed invention is described as the 'telectroscope', but it is unclear whether this is his name for it, or a journalistic response based on the earlier telectroscope narrative. Senlecq's detailed proposals did not appear until 1882, but the first vague intimation is noted in a French language periodical dated December 1878.<sup>131</sup> A slightly more detailed article then appeared in *Le Monde*, written by French Jesuit physicist and author, L'Abbé François-Napoléon-Marie Moigno. It was published on January 16th 1879, then translated and printed in the London *Times* on January 24<sup>th</sup> 1879.<sup>132</sup> The contents of the article were then reproduced in many other journals and periodicals around the world.<sup>133</sup> From this article the proposed operation of the device described can be studied. It is really a remote photograph reproducing device, using a pencil at the receiving end actuated by an electromagnet. In this way the 'photographed' image produced by the selenium camera is recreated at the distant receiving end using a pencil to 'draw' the photograph. Senlecq's later

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<sup>127</sup> de Paiva, "La Telescopie Electrique".

<sup>128</sup> Lange, "The contribution of Adriano de Paiva"

<sup>129</sup> de Paiva, "Other Accounts of the Electric Telescope".

<sup>130</sup> de Paiva, "A telefonia, a telegrafia e a telescopia", 414-416.

<sup>131</sup> "Télectroscope", *La science pour tous*.

<sup>132</sup> Moigno, "Télectroscope", Jan 16 1879; "The Telectroscope", *The Times*, 1879.

<sup>133</sup> Lange, "Constantin Senlecq".

description of the device provides drawings of the proposal and embellishes the idea with more detail and refinements.

In parallel with the de Paiva's idea about using selenium there were proposals from other inventors who managed to be more specific about their methods and ideas, all using selenium as the light sensitive element. The earliest of these is a proposal by George R Carey, a Boston (United States) surveyor, working for Boston City Hall. Carey's first proposed system, simply known as the selenium camera, was a non-scanning type based on a multi-cellular mosaic of selenium cells each connected by individual wires to corresponding point in the matrix on a chemically treated sheet of paper, producing an image by electrochemical decomposition. The first intimation of the idea appeared in May 1879 in *Scientific American* as a very brief report and assigned the title '*The Telectroscope*', attributed to Senlecq.<sup>134</sup> A more detailed description of the proposal first appeared in *Scientific American*<sup>135</sup> and was then followed up by a fuller version in the periodical magazine *Design and Work* published in London.<sup>136</sup>

Alongside the rumours about Bell's photophone and Carey's claims, another clutch of stories about distant vision inventions appeared around the world in 1880. Of the two most common reports, one was a hoax; the diaphote, created by American inventor Dr H E Licks, of Bethlehem, Pennsylvania,<sup>137</sup> and the second a serious proposal, the telephote, envisaged by fellow Americans, patent attorney brothers, MD & TA Connolly and T J McTighe.<sup>138</sup> 'H E Licks', was meant to be read as 'helix', and was a pseudonym of civil engineer and academic Mansfield Merriman. Practical demonstrations were claimed for the diaphote, said to have taken place in Reading, Pennsylvania. The fanciful reports of the demonstrations are detailed,

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<sup>134</sup> "The Telectroscope", *Scientific American*.

<sup>135</sup> Carey, "Seeing by Electricity", article published in Britain.

<sup>136</sup> Carey, "Seeing by Electricity", article published in the United States.

<sup>137</sup> "Forms and Colour by Wire", *The Reading Eagle*, 1880; "The Diaphote", *Nelson Evening Mail*, 1880.

<sup>138</sup> "Seeing by Telegraph", *Colonist*, 1880 (New Zealand); "More Wonders", *Canadian Illustrated News*, 1880 (Canada).

unlike the technical descriptions of the devices which are vague, possibly inspired by Carey's proposals. Furthermore, in a report of the lecture in the *Bethlehem Times*, an audience member was named as 'Prof. M E Kannich', another obviously dubious pseudonym.

The serious proposals of Carey, or the similar claims of Connolly and McTighe, do not represent a true 'seeing at a distance' concept, as the inference is that they were suggesting a one-time process producing one photographic like image, not a moving sequence. Carey expanded upon the idea in his second idea published in the same article, describing a clockwork driven spiral scanning scheme, having an arm with a conducting stylus at its tip exploring each element of the selenium array in sequence.<sup>139</sup> In this way only one signal wire was needed, obviating the need for an impractical number of parallel connecting wires. No attempt was made to calculate how many elements would be needed to produce a useful image, but quite detailed drawings of the mechanisms and their construction were shown in the article.

Another contemporary suggestion came from a medical doctor in Dublin, Ireland in 1879. An ophthalmic surgeon by profession, Denis Redmond approached his ideas for 'distant vision' using the human eye as his model, commenting in the British engineering magazine, *English Mechanic*: 'By using a number of circuits, each containing selenium and platinum arranged at each end, just as the rods and cones are in the retina ...'.<sup>140</sup> His approach was similar to Carey's first method - an array of selenium cells at the 'camera' end with individual connections wired to the receiving device array. The important difference between his and Carey's idea was in the receiving display. Redmond had opted for an array of platinum wires driven with sufficient current to cause incandescence. This approach was implicitly 'distant vision', and not 'distant photography' or a facsimile proposal, in that the image would be continuous and able to display moving images. Redmond's idea was only published in the *London Times* and in the *English Mechanic*, but some elements of

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<sup>139</sup> Ibid.

<sup>140</sup> Redmond, "An Electric Telescope".

his thinking were echoed in later publications.<sup>141</sup> The description in the *London Times* is brief, but Redmond claimed: ‘I have succeeded in transmitting built-up images of very simple luminous objects.’ He went on to explain his hopes for perfecting the device, citing the slow response time of selenium and the number of interconnecting wires as being his primary problems; these are two recurring difficulties, the former plaguing all selenium based systems and the latter resulting in the adoption of scanning processes. In at least claiming practical experimentation having results, Redmond is unique amongst the ‘serious’ initial wave of ‘distant vision’ inventors and scientists in the last two years of the 1870s.

Into the early 1880s, there were two more practical demonstrations, one being by British inventor Shelford Bidwell, and the other by British electrical engineer-scientists, William Edward Ayrton and John Perry. Bidwell, a lawyer, had by the late 1870s become a fairly well known physicist and inventor in London’s academic circles, having joined the Physical Society of London in 1877.<sup>142</sup> The electrical properties of selenium caught his attention resulting in his March 11<sup>th</sup> 1881 lecture at the Royal Institution on ‘Selenium and its applications to the photophone and telephotography’. This was widely reported in the technical journals securing publication not only in the Royal Institution’s *Proceedings*, but in the *English Mechanic* magazine and *Chemical News*.<sup>143</sup> Bidwell’s machines (which still exist in the Science Museum, London) consist of two rotating drums - one at the sending end and one at the receiving destination (see Figure 2.5). The simple image to be transmitted (cut from tinfoil) was projected by magic lantern on to the rotating drum, and by means of a small aperture in the drum a selenium photocell inside produced a variation in resistance according to the instantaneous position of the slit. At the receiving end (mechanically coupled in the demonstration to ensure synchronisation of rotation), the image was reproduced by exposing a piece of potassium iodide soaked paper to the electrical variations from the sending end.

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<sup>141</sup> Redmond, “Seeing by Telegraph”; Carey, “Seeing by Electricity”, 570. Carey can be seen to use very similar terminology to Redmond.

<sup>142</sup> James, “Bidwell, Shelford”.

<sup>143</sup> Bidwell, “Telegraphic photography”. Also published in: *English Mechanic*, Apr 22 1881, 158-159; *World of Science*, Apr 29 1881, 180-181, and in *Chemical News*, 1881, 1-3 and 18-21.

This was a form of telephotography, and Bidwell reported that the response of the selenium was so low that the process took a very long time to deliver the image which was further restricted to being a silhouette. Bidwell's system was an optical version of Scottish inventor Alexander Bain's 1843 facsimile machine, based upon synchronised swinging pendulums using electrical point contact modulation, which was superseded by later versions of the Frederick Collier Bakewell and Ludovic D'Arlincourt copying telegraphs.<sup>144</sup> The significance of the demonstration and the wide reporting of it lie not just in the use of selenium and direct optical imaging, but in the adoption of scanning, breaking an image down into parts and sequentially sending the information over a single wire. In this it was similar to Carey's second method of spiral scanning, but Bidwell had gone much further by actually demonstrating a working (albeit limited) system.

Another clutch of ideas which appeared about 'distant vision' in this period were those of Ayrton and Perry, academic scientist-engineers working, often as duo, in the field of electric traction and telegraphic engineering metrology. After an early career in telegraphy in India, Ayrton became professor of physics and telegraphy at the Imperial College of Engineering in Tokyo, subsequently becoming a lecturer in electrical engineering at Finsbury College in London.<sup>145</sup> Perry was an engineer-mathematician with expertise across electrical and mechanical engineering. His early career as an academic culminated in his professorship in civil engineering at the Imperial College in Tokyo, working alongside Perry.<sup>146</sup> Ayrton and Perry's five year contracts in Japan ended at about the same, and both returned to London in 1879. Whilst in Japan they had studied the Japanese (and Chinese) magic mirror, an optical device capable of projecting a fixed image over several hundred yards. The technique was unknown to Western science, and Ayrton and Perry delivered a

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<sup>144</sup> Bain, "Electric Time-pieces and Telegraphs", British Patent Office, No. 9745, 1843. This patent describes, amongst other ideas, synchronised line by line sequential scanning '... for taking copies of surfaces at distant places by means of electricity'; Bakewell, *Electric Science*; Bakewell, "Electric Telegraphs"; d'Arlincourt, "Improvements in electric Telegraphic Apparatus", Patent No. 1920.

<sup>145</sup> Gooday, "Ayrton, William Edward".

<sup>146</sup> Gooday, "Perry, John".

lecture to the Royal Society about their analysis and findings on it, which subsequently appeared as a long paper in the society's *Proceedings* in 1879.<sup>147</sup> They believed that such a technique could be used as a form of 'distant vision' by using an array of electromagnets to modulate the image formed by the magic mirror.<sup>148</sup> The duo continued their interest in 'distant' vision, describing a series of techniques which might be employed. Their first complete proposal was to use an array of selenium squares, individually connected to corresponding receiving squares, comprised of electromagnetically actuated apertures modulating the intensity of a light source. They demonstrated the principle, using just one square of selenium and one aperture modulator, to the Physical Society in London in 1881.<sup>149</sup> A later modification to the suggestion was the use of the recently discovered Kerr Cell as a light amplitude modulator to replace the mechanically actuated shutter system, but this was never shown. A simple scanning system was also proposed by the duo consisting of a rotating arm with a single line array of selenium cells and a corresponding mechanism at the receiving end using a line array of light modulators. Much of their work was discussed and developed via the medium of the letters pages of the journal *Nature*.

## **2.5 No easy solution, 1881 – 1900**

From the early 1880s on to 1900 the pace of suggestions concerning how to accomplish 'distant vision' slowed, and there were no more practical public demonstrations. The beginnings of modern science fiction in this period also produced further examples of speculation about 'distant vision', which increased interest in a practical realisation of the dream. The March 1898 issue of the *Electrical Engineer* sums up the situation in the editorial entitled 'Next Please':

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<sup>147</sup> Ayrton and Perry, "Magic Mirror".

<sup>148</sup> Lange, "L'influence des miroirs magiques japonais". Lange describes Ayrton and Perry's ideas about using electromagnets behind a large mirror to electrically emulate the operation of a magic mirror.

<sup>149</sup> Ayrton and Perry, "Seeing by electricity". Although this paper describes the lecture and demonstration at the Physical Society in London, there is no record of the session in the Physical Society archives.

In the stellar universe some comets are periodic visitants to regions within the ken of man, and in the sensational literature of the day “Seeing by Electricity” is becoming a periodic headline.<sup>150</sup>

The leader carries on in this vein, describing various methods of scanning, the very low sensitivity of selenium, and its problem with speed of response. Essentially the article is complaining about misleading claims, patents and articles concerning ‘distant vision’. It concludes:

We strongly condemn this method of exploitation by sensational headlines and articles, and warn our readers to keep a very open mind till the much talked about apparatus has been under the examination of men who understand the matter.<sup>151</sup>

Leading up to this salutary warning, numerous proposals had been put forward for complete systems and elements of a system for ‘distant vision’, all set alongside reports detailing spoof inventions, further examples of cartoon art speculation and works of science fiction. The most significant of the ‘real’ inventions in this twenty year period are three mechanical scanning schemes, one based on spinning aperture discs, one on rotating mirror drums and another on oscillating mirrors; all three of these methods could produce a scanning system, but none of the proposers addressed any of the issues regarding just how many picture elements or pictures per second might be needed. One analysis of the theoretical requirements was carried out before the end of the century by French scientist Louis ‘Marcel’ Brillouin, and his pessimistic view suggested that none of the then known schemes would ever be likely to work.<sup>152</sup>

Despite this, these three fundamental methods came to dominate practical thinking about ‘distant vision’ by the end of the nineteenth century and on into the twentieth. Numerous variants of disc, drum and mirror scanners appeared, some with built in

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<sup>150</sup> “Next Please!”, *The Electrical Engineer*.

<sup>151</sup> Ibid., 305.

<sup>152</sup> Brillouin, “Photographing objects at a very great distance”, 34.

lenses, some combining one or more of the basic forms and yet more suggesting ways of modulating light beams. Synchronisation of the mechanical sender and receiver mechanisms also produced many variants, whilst some inventors were happy to disregard the problem. Many years earlier, Bain had addressed the issues of synchronisation in his work on facsimile, and his methods were often cited.<sup>153</sup> All of the variants used the selenium cell as the fundamental pick-up device.

### 2.5.1 Speculation grows

The telephonoscope cartoon of du Maurier (see Section 2.4.1) almost certainly inspired French cartoonist and writer Albert Robida to develop his own thoughts on the topic, but unlike Du Maurier, he returned frequently to the idea many times in his career. His first known work on the theme was published in 1883, in the first of a series of his three books of futuristic literature. *Le Vingtième Siècle*, (The Twentieth Century), published in 1883, is set in the year 1952, and tells the story of Hélène, her life, experiences and everyday life.<sup>154</sup> One illustration in this book depicts an image very similar to that of du Maurier, and is captioned ‘*Le Journal Telephonoscopique*’, (see Figure 2.4, top left). Another foray into distant vision by Robida appears in *Le Vingtième Siècle - La Vie Électrique* (The Twentieth Century: The Electrical Life), published in 1890, depicting several other potential uses for the technology, one being distant education and teaching (Figure 2.4, bottom left). Another of his variants on the idea is the concept of the theatre brought into the home, presumably to many households simultaneously. It appeared as a colour lithograph in later editions of *Le Vingtième Siècle*, and depicts a gentleman enjoying the delights of the Paris theatre scene (Figure 2.4, top right). This example possibly borrows from an idea circulating in journals from 1881 concerning a system called the théâtrophone, a wired broadcasting system utilising the technology of the telephone, but sending to many people in their homes, not just for individual point-to-point communication.<sup>155</sup> This represents a departure from the existing concept of peer to peer communication, and suggests a form of ‘broadcasting’. The théâtrophone became a real, practical

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<sup>153</sup> Ibid.

<sup>154</sup> Robida, *The Twentieth Century*.

<sup>155</sup> Laster, “Théâtrophone”.



invention, and allowed many people to ‘listen in’ to the activities in a remote theatre. There were installations in Paris and in Stockholm using remote boxes whereby the public could insert coins into a slot to hear the theatre programming. As a curiosity it was a success, but technical limitations outstripped any genuine appeal until amplification could be introduced in the twentieth century. Robida appears to have taken the concept and extended it into vision, effectively describing a new entertainment medium.

The idea of ‘distant vision’ was tackled by other science fiction authors, including Jules Verne, with his short story *In the Year 2889*.<sup>156</sup> The narrative describes a ‘phonotelephote’, comprised of ‘sensitive mirrors’ which enables telephone communications with images over long distances. The story may well have been written by his son, Michel in 1889, as a commission by James Gordon Bennett, Jr., owner of the *New York Herald*.<sup>157</sup> E M Forster also briefly describes a ‘distant vision’ machine in his short story of 1909, *The Machine Stops*, where the ‘speaking apparatus’, used for communications, is able to instantaneously send and receive images as well as sound. These works present a largely dystopian view of future society, and ‘distant vision’ machines form part of the gloomy predictions. It is difficult to ascertain how influential such novels were on the actual practical development of ‘distant vision’, but it is almost certain that the work of Du Maurier and Robida were effective and inspirational, having being so widely distributed. Their work is much more positive and optimistic about what such technology could be used for, whereas the short stories present a much more disturbing view of the future.

### **2.5.2 Further practical suggestions**

The initial flurry of articles in journals, pamphlets, periodicals and newspapers speculating about ‘distant vision’ in the three years to 1881, began a steady but very limited interest in the idea through to the turn of the century. There is no known evidence of any interest being shown by commercial companies, and all experimentation was being carried out by lone inventors alongside a few interested

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<sup>156</sup> Verne, “In the Year 2889”, 262.

<sup>157</sup> Wilfong, “In the Year 2889, Editor’s Notes”.

academic scientists and engineers. Apart from the likely occasional meetings at professional institutions, this small and isolated band of experimenters was linked solely by specialist publications, many having a transnational readership, and the occasional news story in national newspapers which might, on occasion, be picked up by news outlets in other countries. Practical demonstrations of concepts relating to ‘distant vision’ were rare in the late nineteenth century. Nothing could be made to work, even in a limited way, but this did not hinder ideas and patents from young men with fresh ideas, one such being Paul Gottlieb Nipkow, a German student.

In January 1884, Nipkow, then studying Natural Sciences at the University of Berlin, patented a seeing at a distance scheme entitled *Elektrisches Teleskop* (Electric Telescope).<sup>158</sup> The entirely theoretical scheme utilised two spinning discs, one at the transmitting end and the other at the receiving point with each disc having a series of small holes punched in it arranged in a spiral pattern (see Figure 2.6. and Appendix 2.1b). In a 1933 newspaper interview, Nipkow describes his initial inspiration for his proposal as him having received a Bell telephone on loan from the German Post Office for just two hours in 1883.<sup>159</sup> He recalled being astounded about how simple it was, and musing whether the ideas could be extended to vision. Some of this background and quite a lot the technical reasoning to his idea appeared a near contemporary article in 1885, which was translated and appeared in a French language journal, but there is no currently known record of a contemporary English version or publication.<sup>160</sup>

The patenting system of the new German Empire state was created by the Unified National Patent Act of 1877 and was based on the American system – using the principle of ‘first to invent’. As In the United States, as well as being novel, any invention had to be ‘reduced to practice’, thus proving that the invention worked. This could be achieved either by providing a working model to the patent office or by showing evidence of actual practical usage in an application. Furthermore, the

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<sup>158</sup> Nipkow, “Elektrisches Teleskop, Kaiserliches Patentamt”, Patent No. 30105.

<sup>159</sup> Dunlap, “A Fifty Year Riddle”.

<sup>160</sup> Nipkow, “Der Telephotograph und das elektrische Teleskop”; Clemenceau, “The vision of objects at a great distance”.

German state reserved the right to re-assign the patent if the holder failed to use the invention within a reasonable time.<sup>161</sup> The cost of the grant of a German patent was relatively high compared to American patents, and was thus similar to the British situation, potentially deterring inventors from pursuing the process. Furthermore, under German patent law, Nipkow would have been required to prove the patent and reduce it to practice, something which would have been impossible with late nineteenth century electro-technology. His suggestion remained as just a patent and was never reduced to practice during the lifetime of the patent. The technical barriers with regard to the electro-optical efficiency of the system were just too great, but despite the limited published information other inventors attempted to elaborate and develop the idea as a theoretical concept. Most of the variants concentrated on the receiving side, and how to vary the strength of the light source. One method to achieve this was the manometric modulator, using gas pressure to vary the strength of a flame, and this can be found in a variant suggested by American scientist Leon Le Pontois in 1893.<sup>162</sup> Another method was an electromagnetically controlled optical aperture, as featured in suggestions by Brillouin (1891)<sup>163</sup>, and by Swiss physicist Frantz Dussaud (1898).<sup>164</sup> Russian scientist M Vol'fke suggested using a Geissler tube (1898)<sup>165</sup>, and Australian inventor Henry Sutton proposed using polarised light and a Kerr Cell in his telephane of 1890.<sup>166</sup> Nipkow's idea inspired many scientists and inventors, despite the very limited initial exposure of it in the international journals and magazines.

Nipkow's disc was a two dimensional 'flat' scanner with its spiral of holes on a disc, whereas the other two fundamental concepts from the late nineteenth century, the drum and oscillating mirrors, operated in three dimensions. The drum method, conceived in 1889 by French industrialist and politician Jean Lazare Weiller, formed part of his distant vision machine known as the phoroscope. Weiller's proposal was

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<sup>161</sup> Khan, "Study Paper 1a Intellectual Property", 19-20

<sup>162</sup> Cochrane, *Modern Mechanism*, 63-65.

<sup>163</sup> Brillouin, "Photographing objects at a very great distance".

<sup>164</sup> Armengaud, "The Dussaud Téléoscope".

<sup>165</sup> Uralov, *Essays on the History of Television*, 53-54.

<sup>166</sup> Sutton, "Tele-photography".

similar to that of Nipkow in utilising the same mechanical scanning hardware at the pick-up and the receiving ends of the system (see Figure 2.7 and Appendix 2.1c), and also adopting the ubiquitous selenium cell for the pick-up, but the receiving end differed in employing a manometric system comprised of a telephone receiver moving a gas lamp in and out of alignment with an optical stop. The mirrors mounted on the periphery of the rotating drums at both ends of the system required considerable precision in their construction as the tilt of each successive mirror increased by a tiny amount relative to its predecessor.

Weiller published his idea in the French language journal *Le Génie Civil* (The Civil Engineer) in 1889.<sup>167</sup> This was followed almost immediately in *La Lumière électrique* (The Electric Light),<sup>168</sup> and then by a full report of the article in English in *The Telegraphic Journal and Electrical Review*,<sup>169</sup> which produced a challenge to the priority of the idea in the next issue by British inventor, Llewelyn B Atkinson.<sup>170</sup> The challenge cited publication of such a proposal seven years earlier, then assigned only to 'W.L.',<sup>171</sup> but claimed later by British scientist William Lucas.<sup>172</sup> The controversy resurfaced in 1929 in *The Electrician*, which carried a report describing hardware and unpublished work produced by Atkinson at an exhibition in support of his long standing claims regarding priority.<sup>173</sup> Whether such controversies over priority ever increase interest in a topic is debateable, but the principles of Weiller, Atkinson and Lucas reappear almost as often in the following decades as those of Nipkow.

Towards the close of the nineteenth century, another mirror based concept appeared, based on just two oscillating scanners, devised by Polish schoolmaster and inventor Jan Szczepanik. His proposals are important, but more importantly the controversy

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<sup>167</sup> Weiller, "Remote viewing by electricity", 570.

<sup>168</sup> Weiller, "On distant vision by electricity".

<sup>169</sup> "Seeing to a distance by electricity", *The Telegraphic Journal and Electrical Review*.

<sup>170</sup> Atkinson, "seeing to a distance machine", 683.

<sup>171</sup> Lucas, "The Telectroscope", signed just 'W.L.'.

<sup>172</sup> Lucas, "The Scanning Principle in Television".

<sup>173</sup> "Television Exhibition", *The Electrician*.

surrounding his claims about a working machine received wide publicity and fed more rumour and speculation about ‘distant vision’. His suggested method, which was granted a British patent in 1897, departed from the drum and disc techniques by using two scanners, one horizontal and one vertical, applied in succession.<sup>174</sup> Arguably not as elegant as the drum or disc method, the concept is easily grasped and performs the rapid point by point exploration of a surface in a simple manner. The core of Szczepanik’s proposals for scanning consisted of two oscillating mirrors, one creating a ‘slow speed’ scanning axis and the other a ‘high speed’ scanning axis (see Figure 2.8 and Appendix 2.1d). The use of mirrors was not new, French scientist, Maurice Leblanc, had in 1880 proposed the use of a single mirror vibrated in both axes. Mechanically, it was a complex method and difficult to realise in practice. Separating the scanning into discrete horizontal and vertical planes simplified the process greatly.<sup>175</sup>

The controversy over Szczepanik’s proposals stems from claims made in journals and magazines for a working system and demonstrations witnessed. The claims begin not long after the patent is published with articles in the *Electrical Engineer*, the *Daily Telegraph*, the *New York Times*, and several mentions by Mark Twain who had named him ‘the Austrian Edison’, as he was then living in part of Poland occupied by Austria.<sup>176</sup> The most audacious claims appear in *Pearson’s Magazine*, a periodical specialising in speculative journalism which by 1899 was being published in the United States as well as Britain. The article, *Seeing by Wire*, was written by American author Cleveland Moffet, more usually known for his detective stories, but also writing technical articles about new developments in magazines.<sup>177,178</sup> Moffett’s claims for Szczepanik’s system suggested that it was first tested in 1896, achieving a range of 60 km. He concluded in an 1899 article appearing in *Pearson’s Magazine*:

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<sup>174</sup> Szczepanik and Leinberg, “Method and Apparatus for Reproducing Pictures and the like at a Distance by Means of Electricity”, Patent No. 5031.

<sup>175</sup> Leblanc, “Etude sur la transmission électrique”, 477-81.

<sup>176</sup> Burnham, “Austrian Edison”.

<sup>177</sup> Moffett, “Seeing by Wire”.

<sup>178</sup> Ibid.; Moffett, “Marconi’s Wireless Telegraph”.

Whatever comes over the wires will be projected plainly for everyone to look at – colours, movements and all, just as in life. We can show a charge of the cavalry, the finish of a race, the launch of a battleship, the movements of a street and similar scenes, without end, and each as it is actually transpiring at some distant point.<sup>179</sup>

These were bold claims, but the saga even survived cynical reports in the *Electrical Engineer* concerning financial arrangements, whereby Szczepanik and his co-assignee on the patent, Ludwig Kleinberg, an Austrian banker, stood to make 3 million francs from the central committee of the up-coming Paris Exposition of 1900, if the device could be shown there. The *Electrical Engineer* noted: “We are not aware of the existence of a central committee of the Paris Exposition”.<sup>180</sup> The device was never shown at the Exposition, but Szczepanik’s ideas about mirror scanning continued to stimulate experimentation and invention, alongside Nipkow’s disc, Weiller’s drum and the non-scanning schemes. The Paris Exposition drew together many interested individuals on the subject of ‘distant vision’, but reports of the proceedings gave prominence to a non-technical issue – a new name for the proposed new invention; that name was ‘television’, as I will next describe.

## **2.6 ‘Television’: a new word is born – Paris 1900**

Considerable confusion surrounds the first use of the actual word ‘television’, or ‘far-sight’, derived from the Greek ‘tele’ and the Latin ‘visio’. The etymology is thus undoubtedly ‘half Greek and half Latin’, an observation apocryphally attributed to the contemporary editor of the *Manchester Guardian*.<sup>181</sup> The person who actually coined the word was a Russian military engineer, Professor Constantin Dimitri

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<sup>179</sup> Moffett, “Seeing by Wire”.

<sup>180</sup> “Szczepanik Telectroscope”, *The Electrical Engineer*.

<sup>181</sup> C P Scott, editor of the *Manchester Guardian* from 1872-1929, is popularly associated with this quotation, said to be from 1928: ‘Television? The word is half Latin and half Greek. No good can come of it’. I have not been able to find the source of this quotation, but it appears in numerous books and articles, including: BBC, *The story of BBC Television - How it all began*, <http://www.bbc.co.uk/historyofthebbc/resources/tvhistory/index.shtml> Accessed 01/24/2011; Fisher and Fisher, *Tube*, 9 and 355; Briggs and Burke, *A Social History of the Media*, 184.

Perskyi, speaking at a conference in Paris in August 1900.<sup>182</sup> There was (and remains) dispute about whether the actual word ‘television’ was precisely what Perskyi intended (although the meaning is clear), but this did not hinder its adoption. André Lange has suggested that the word *Fernsehen* (far-seeing) had been adopted by German scientists, and that Perskyi duly translated this into Russian as *televisija*, which in turn became *télévision* for the purposes of reading his paper in French. The paper was then reported in *The Electrician* in the English form, television.<sup>183</sup> I am not convinced by this argument, despite the common use of the German language in technical literature at that time, as Russian practice appears to have been similar to the classically educated English habit of deriving new scientific names directly from Latin and/or Greek roots. Notwithstanding these questions, this conference, and the imminent turn of the century, suggest a good date to survey the state of the development of the technology to be known, if not exclusively, but commonly, as ‘television’.

I have described earlier in this chapter how the post 1870s dream of ‘distant vision’ had inspired writers, scientists and inventors to think about what such a device could be used for and even how it might be made to work. The discovery of the electro-optical properties of the element selenium, the development of long distance telephone and telegraphic communication by wire, wireless telegraphy and cinematography all fuelled thoughts about how to realise the related dream of ‘distant vision’. The Paris conference that Perskyi attended, the Congrès International D’Électricité, was held from August 18-25 1900 and formed part of the huge Exposition Universelle celebrating the achievements of the previous century with a view to enhancing them in the next.<sup>184</sup> Perskyi, Professor of Electricity at the Artillery Academy of Saint Petersburg, presented his brief paper describing the known state of television development in the final session of the conference.<sup>185</sup> He did not describe what television might be able to do, nor what it might be used for, concentrating solely on technical ideas. It was mainly an encouraging report, noting

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<sup>182</sup> Lange, “L’apparition du mot ‘télévision’”.

<sup>183</sup> Ibid., Note 5, translated and summarised by author.

<sup>184</sup> Chappel, “Exposition Universelle”.

<sup>185</sup> Perskyi, “Television with electricity”, 55.

Paul Nipkow's disc, as described in Section 2.5.2, and developments of this idea by Russian researchers such as P I Bachmetiev and A A Polumordvinov. Bachmetiev had suggested a system based on a single selenium cell scanning spirally, published in 1885<sup>186</sup> and Polumordvinov had patented in 1899 a complex colour capable scanner based on concentric slotted discs rotating at different speeds.<sup>187</sup> Perskyi's paper also reviewed light-sensitive photo-electric phenomena<sup>188</sup> that might be applicable to a television camera, reporting on the discovery of the photoconductive element selenium, and the somewhat less promising photovoltaic effect of iodised silver.<sup>189</sup> He implied that selenium, despite its slow response speed, would still probably be the best option for television. He also presented a simple calculation, the details of which he did not show, but almost certainly similar to that of Brillouin which I described in Section 2.5 of this chapter. From this he deduced that, assuming a picture repetition rate of 10 frames per second, a picture size of 10 x 15 cm and a 'spot' size of width 0.25 mm, 360,000 'oscillations per second' would be required.<sup>190</sup> This was another indication of the serious problems of speed that any television system offering a reasonable picture quality would face. Brillouin's analysis of almost ten years earlier had been published but Perskyi's reiteration was publicised to a much wider audience.<sup>191</sup>

The reporting of the 1900 Paris Exposition suggests there was much uncertainty about exactly how a 'distant vision' machine might work, with no mention of its eventual possible application, despite a more coherent expression of its purpose in

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<sup>186</sup> Burns, *Television*, 116.

<sup>187</sup> Shiers, *Bibliographic Guide*, 36.

<sup>188</sup> The known photovoltaic effects of the time generated only very tiny currents and were not considered usable for anything practical.

<sup>189</sup> Perskyi, "Television with electricity", 55.

<sup>190</sup> Perskyi does not perform the calculation in his paper but it will be of the form: screen area of 100 x 150 mm = 15,000 mm<sup>2</sup>, with a spot size of 0.25 mm will thus result in 15,000/(0.25 x 0.25) spots = 240,000 per picture. With 10 frames per second the number of spots per second will be 240,000 x 10 = 2,400,000. This does not tally with his figure of 360,000 but it illustrates the point about the sheer quantity and speed of information to be sent.

<sup>191</sup> Brillouin, "Photographing objects at a very great distance".



the word 'television'. What such a system should or would be used for was still very much undefined, but there was hope amongst inventors and engineers that new precision electro-mechanical machines could yield success, despite the enormous technical challenges.

## **2.7 Dashed dreams, 1901-1918**

During the first years of the twentieth century, the new fields of wireless, sound recording and cinematography were all enjoying technical and commercial successes. Two out of these three, sound recording and cinematography, relied upon mechanical technology. Even contemporary wireless largely depended upon rotating electrical machinery to develop the necessary power for spark transmitters and electro-mechanical coherers to detect the wireless signals at the receiving end. Such electro-mechanical methods had proved to be successful in many fields of electrical invention and such technology had been diffused throughout the developed world. To an early twentieth century inventor, the lack of photo-electric speed and the sheer quantity of individual picture points would have been a daunting prospect, as previously evidenced by Perskyi at the Paris exposition in 1900. In the first decade of the twentieth century, the choice between scanning and non-scanning systems was still unresolved, the choice being between thousands of wires linking transmitter and receiver, or the problem of devising a suitably fast and accurate electro-mechanical method for scanning. The small number of inventors and researchers interested in television received little attention from newspapers, magazines, or even learned journals, and the field had effectively ceased to be anything other than purely speculative.

From the beginning of the twentieth century until just after the Great War, the prospect of a near term working television system appeared to recede, despite patents and potentially useful technologies appearing continually.<sup>192</sup> The theoretical non-scanning schemes put forward in the late nineteenth century, such as that of Carey's first suggestion (described earlier in this chapter), were still reappearing in the early twentieth century, such as a new proposal by Bidwell, appearing in 1907, based on

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<sup>192</sup> Shiers, *Bibliographic Guide*, 40-42, Table 5 shows a chronology of suggested television technologies from 1901 to 1918.

an array of selenium cells connected by 90,000 wires to a similar array of light valves.<sup>193</sup> This is surprising, given his earlier enthusiasm for scanning, as evidenced by his 1881 demonstration to the Royal Institution, but I have been unable to identify a reason for his shift in thinking. Bidwell was not alone with his interest in non-scanning schemes, German scientists Ernest Ruhmer and Friedrich Lux also presented new methods. Lux's method utilised a similar array of selenium cells, not connected by individual wires, but by a system of multiplexed frequencies on a single line. His scheme allocated a frequency to each element in the pick-up array of photo sensitive cells feeding the connecting line, with another array at the receiving end composed of resonant vibrating reed light shutters in front of a light source – an idea echoing the ideas behind the resonant reed harmonic telegraph. Each element would have its own unique frequency, and hence its own transmission channel on the single connecting line, but the sheer number of frequencies required and the limited frequency separation possible proved to be unworkable.<sup>194</sup> Ruhmer's proposal was similar but much more modest with an array of only 5x5 elements and this array was successfully demonstrated in 1909 with plans for a 100x100 system being suggested.<sup>195</sup> A working 5x5 system was realistically possible (25 connecting wires), but had no real practical use as an image transmitter. A system of 100x100 elements (10,000 connecting wires) was a much more viable proposition as a useful system, but not practical. The figure of 150,000 elements in a good 50x50 mm photograph as calculated by Bidwell, would have been even more daunting.<sup>196</sup> Lux's vibrating reed technology overcame such objections concerning the number of wires needed, but his system could not have operated beyond a few hundred elements because of the limitations of the resonance phenomena upon which it is based – nothing further was ever published about this proposed method.<sup>197</sup>

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<sup>193</sup> Bidwell, "Telegraphic photography".

<sup>194</sup> Lux, "Bildübertragung".

<sup>195</sup> Ruhmer, "Der elektrische Fernseher".

<sup>196</sup> Lux, "Bildübertragung".

<sup>197</sup> Vibrating reed techniques, similar to the harmonic telegraph, use frequencies within the audible range, notionally 50 to 20,000 cycles per second. Each 'channel' can only discriminate over a relatively wide range of frequencies and there would not be sufficient spectrum to accommodate 10,000 individual and unique bands. Practical problems with generating precise frequencies and

Ruhmer published a book (German) in 1902 on the electrical properties of selenium, which not only supplied detailed information about the construction of selenium photocells, but also accounts of applications such as the photophone and television.<sup>198</sup> This was one of a small number of more detailed technical works which appeared in the first decade of the twentieth century. How widely read Ruhmer's work was is hard to gauge, but British inventor John Logie Baird does cite this work as being of great use to him when carrying out experiments with selenium as an adolescent in the early 1900s.<sup>199</sup> His work was also given impressive exposure in the American technical magazine *The Electrical Experimenter* published in 1909 with a photograph and full technical details.<sup>200</sup>

In Britain, another inventor, 'Professor' Archibald Montgomery Low, was developing a scanning system for 'seeing by wireless', which he called the televista. Low, not a genuine professor, was derided by the academic establishment for a use of the title 'professor', when he had only briefly been an acting assistant professor at the Royal Ordnance College, and possibly because of his popular literary success writing on science issues.<sup>201</sup> He was though, a serious inventor and scientist, deeply involved in work on guided munitions and automobile engineering. There are claims that his system, an ingenious mechanically racked array of selenium photocells, was demonstrated to the Institute of Automobile Engineers in 1914. This was optimistically reported by the *Daily Chronicle*, *The Times* and the *Daily Citizen*, but other than the details recorded in Low's patent for the machine, there are no further accounts.<sup>202</sup> Grant of the patent itself was delayed by government controls, it was not

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maintaining consistency across the whole audio spectrum also create complex problems. Of the non-scanning class of television system proposals this is the closest to being a credible system.

<sup>198</sup> Ruhmer, *Selenium*, 18-26. Describes several systems invented to date.

<sup>199</sup> Baird, *Sermons Soap and Television*, 22. Describes Baird's appreciation of Ruhmer's book.

<sup>200</sup> Gernsback, "Television and the Telephot".

<sup>201</sup> Bloom, *He Lit the Lamp*, 11. An introduction to Low, written by British aviation engineer, Lord Brabazon of Tara.

<sup>202</sup> *Ibid.*, 65-66.

applied for until 1917, released for publication in 1922 and finally published in 1923.<sup>203</sup>

Some inventors and journalists began to feel that inventing a viable television machine was almost impossible. American technical journalist, Hugo Gernsback, wrote:

Every now and then we see newspaper reports that Mr So and So has discovered the real secret of television, only to be told again a few weeks afterwards that it has not been realized after all.<sup>204</sup>

Gernsback's article is a pre-war view. A post-war impression, looking not just at the technicalities, was offered by writer Arthur Richard Burrows in 1918, which summarised the state of development thus:

The Wireless transmission of photographs is by no means outside the realm of possibility, and some day, not very far distant, it may be possible to provide not merely wirelessly operated tape-machines in mid-Atlantic but pictures illustrative of the days' events. The nightmare of wireless television is unlikely to become a reality for some time. Mechanical and electrical difficulties exist which require for their solution a much more complete knowledge of the nature of light, electricity and ether. Some day the solution may be forthcoming, but as such an invention would be of questionable popularity and its commercial application limited, the inventive faculties in most countries are likely for the present to be turned in other directions.<sup>205</sup>

Burrows' comments appear to be optimistic about still picture transmission but pessimistic about the idea of television, both with regard to the technology and its commercial prospects. In one respect he was behind reality: the wireless

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<sup>203</sup> Low, "Improved Apparatus for the Electrical Transmission of Optical Images", Patent No. 191,405.

<sup>204</sup> Gernsback, "Television and the Telephot".

<sup>205</sup> Burrows, *Year Book*.

transmission of photographs by 1918 was possible, albeit in a very basic form. The impetus for the development of still picture transmission systems was coming from the newspaper publishing sector, military applications relating to map transmission and the need for wireless companies to be able to send non-Roman or Cyrillic script telegraphy such as Arabic and Chinese. The systems that were developed in response to these needs were capable of half tones, or even full tonal graduation, and the slowness of a selenium cell as the photo-electric sensor was not a major problem. Such tonal reproduction capability differentiates such inventions from the earlier point contact machines that were only capable of an engraving style of reproduction.<sup>206</sup>

Mechanical scanning technology was adequate for a single picture, where the time taken to achieve analysis and replay was not a major issue. In addition, such a picture analysis could be undertaken with very high levels of illumination negating the lack of photoelectric sensitivity. By utilising landlines as the transmission medium, successful and potentially useful techniques had been achieved by 1903.<sup>207</sup> German scientist Professor Arthur Korn's machine could produce excellent reproductions by wire with relatively inexpensive machines. Figure 2.9 shows the high quality of the image possible with such technology. It was still a difficult proposition to send such pictures by wireless due to interference, fading and phase distortion and satisfactory systems for the transmission of 'pictures by wireless' did not evolve until the late 1920s, with machines such as the Fultograph.<sup>208</sup> None of this was television, but success with purely electro-mechanical methods for still picture transmission served to encourage developments along these lines.

The majority of the proposals put forward for television systems up until the early 1920s were never tried out in practice. Most were simply that, proposals, described in a patent or a journal article. There were exceptions, such as the work of Russian scientist Boris Rosing (see Section 4.4) and that of Low and of Lux, but most were just paper suggestions of varying quality. The question of a definition of what really

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<sup>206</sup> Burns, *Television*, 19-21.

<sup>207</sup> Korn, "Sur la transmission de photographies".

<sup>208</sup> Erb, "Bildfunk-Empfänger und -Zubehör".

constitutes the definition of 'television' surfaces by the early 1920s, as several still picture telegraphy systems with frame transmission times measured in tens of minutes existed, and also silhouette transmission systems of simple figures by both electro-mechanical scanning and non-scanning methods had been demonstrated by researchers such as Ruhmer. These systems were never presented to the public as 'television'. Demonstrations of such systems were never seen outside of laboratories and the public, with a few exceptions, was essentially unaware of developments through until the mid-1920s. The dream of television was still very much alive, even though the results to date were disappointing and kept within laboratories.

## 2.8 Conclusions

So far as I can ascertain, there was no real ‘dream’ of instantaneous ‘distant vision’ in any of the ancient occidental or oriental cultures, and even where weak evidence can be found, such as in the case of Saint Clare, it is virtually certain that such narratives played no part in shaping the applications of television. I have found no evidence of any concept of such a machine or process in the early modern period, or even through the first 75 years of the nineteenth century. There is a ‘dream’, but it begins suddenly in the late 1870s with the related concept of ‘distant hearing’ (the telephone), colliding with two other stimuli appearing at almost the same time. ‘Distant hearing’ was an accomplished fact by the late 1870s, so why not add seeing to hearing? The main application for the telephone had appeared very quickly – point to point, peer to peer communications. A possible use for a ‘distant vision’ machine evolved directly from that concept, complementing the sound with vision. The Du Maurier cartoon (Figure 2.2) of 1878, which appeared in the widely read *Punch*, shows the spoof ‘telephonoscope’ as a very long range, instantaneous aural and visual communications device. I believe that this cartoon was at the heart of establishing the ‘dream’, imaginatively extrapolating the concept of the telephone to new heights and disseminated to a wide audience.

The telegraph and the telephone could satisfy almost all of the late nineteenth century needs for high-speed communications – the technical and commercial objectives of companies and network operators such as the General Post Office in Britain and the American Telephone & Telegraph and National Bell Telephone in the United States, did not involve notions of ‘distant vision’. Their immediate imperatives revolved around the commercial and technical aspects related to system expansion. Whilst adding vision to the telephone’s sound was undoubtedly attractive as a concept, it would not have added much to the value or efficacy of the communications process: in most instances written or spoken communication is all that is necessary for meaning and understanding to be conveyed. Thus, the focus of the corporate technical research conducted by the telephone and telegraph companies in the nineteenth century was about cost reduction, network capacity, communications range, audio fidelity and switching (exchange) technology. None of

the published ideas or patents of the nineteenth century for ‘distant vision’ originates from people within commercial companies; they all come from a small number of individual inventors and scientists across the world, linked in most cases only by journals and periodicals. This was the era of the ‘hunt and try’ inventor, free to let their imaginations soar, but the complicated concepts of ‘distant vision’ did not quickly succumb to that method of working.

There was an initial flurry of imaginative activity between approximately 1878 and 1881, when there must have been considerable excitement amongst some inventors, engineers, scientists, writers and artists in the idea of ‘distant vision’. The invention of the telephone had received popular publicity, and the relatively simple techniques could be replicated quite easily. The discovery of the photo-electric properties of selenium was only really reported in specialist publications, receiving little more than just one sentence in newspapers, and even in such journals as *Nature*. Muybridge’s work also received extensive popular coverage, as well as in the weekly periodicals and learned journals. The three stimuli, although occurring within the same time period, did not receive equal exposure, or the same kind of treatment, in the contemporary press. Who saw what and when of this coverage is something that will never be known, but a small number of people, of disparate professions, did begin to address the ‘how’ of ‘distant vision’, and to some extent the ‘what for’ in this period. The very small, ad-hoc networks of communication set-up via scientific journals, and even through the letters columns of newspapers and magazines, linked this small number of individuals together, whatever their country of origin. It was a small number of people and hard to estimate, but there were only 31 patents taken out world-wide for ‘distant vision’ proposals between 1878 and 1901.<sup>209</sup> Further evidence of the relatively low level of activity is the small amount of coverage in the popular press and in the learned journals. The flurry, at its height, was never more than a very small group of interested individuals.

Through to the end of the century, only a few more inventors joined this small ‘club’, linked largely by periodicals and learned journals, plus the very occasional

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<sup>209</sup> Shiers, “The Rise of Mechanical Television”, 511, Figure 1, columns ‘A’ and ‘B’.



lecture and disclosures through the patent system. This latter linkage is interesting in that the differences between the American and British/Continental systems appear to surface, with speculative patents such as Szczepanik's and Nipkow's appearing in Europe, but no such equivalents from the United States. This could, of course, be explained by chance or other factors, but I believe that it is evidence of the need for a working model, the 'reduction to practice' clause, in the American system which can deter a would-be patent applicant – knowing, or at least strongly suspecting, that their system would not work in practice.

The period from the turn of the century through to the end of the Great War was largely one of scepticism and doubt with regard to any near-term invention of practical television. No real need for television existed, the telephone and the telegraph satisfied most instantaneous communication needs, and by the end of the period 'pictures by wire' machines were fulfilling the very narrow, specialist needs of newspaper publishers for rapid picture transmission. The concept of television remained an intellectual challenge, pursued largely by individual lone inventors with a small number of professional scientists and engineers taking an interest in the problem.

In the next chapter I will explore how the dream began to be fulfilled by the electro-mechanical technologies proposed in the late nineteenth century, but enabled by the technology of thermionic valve amplification which had seen a huge impetus in its development during the Great War. In parallel with this, the rise of sound broadcasting in the 1920s suggested a real use for television – adding pictures to the sounds from the wireless.

## Chapter 2 Figures



**Figure 2.1 Master of Heiligenkreuz (artist) Austrian, active early 15th century.**

**The Death of Saint Clare, c. 1400/1410.**

Picture source: National Gallery of Art (United States).

[http://www.nga.gov/cgi-bin/tinfo\\_f?object=41698](http://www.nga.gov/cgi-bin/tinfo_f?object=41698)

Accessed: 05/07/2010.



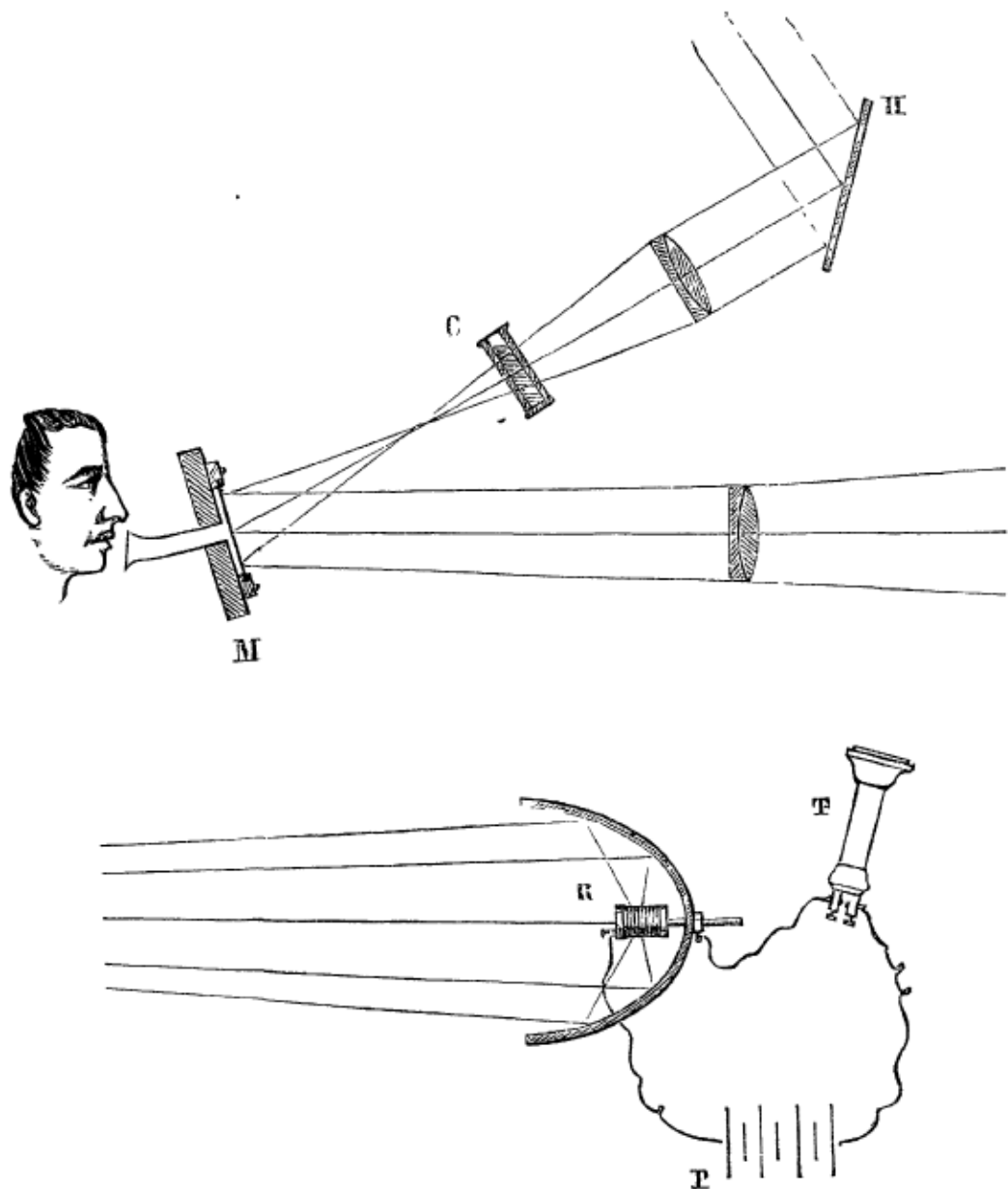
**EDISON'S TELEPHONOSCOPE (TRANSMITS LIGHT AS WELL AS SOUND).**

(Every evening, before going to bed, *Pater- and Materfamilies* set up an electric camera-obscura over their bedroom mantel-piece, and gladden their eyes with the sight of their Children at the *Antipodes*, and converse gaily with them through the wire.)

*Paterfamilias* (in *Wilton Place*). "BEATRICE, COME CLOSER, I WANT TO WHISPER." *Beatrice* (from *Ceylon*). "YES, PAPA DEAR."

*Paterfamilias*. "WHO IS THAT CHARMING YOUNG LADY PLAYING ON CHARLIE'S SIDE?" *Beatrice*. "SHE'S JUST COME OVER FROM ENGLAND, PAPA. I'LL INTRODUCE YOU TO HER AS SOON AS THE GAME'S OVER?"

Figure 2.2 George du Maurier's cartoon in *Punch* of Dec 9 1878      Picture source: Punch Archive, Dec 9 1878.



**Figure 2.3**  
**Bell's photophone. Sender**  
**(top), receiver (bottom).**

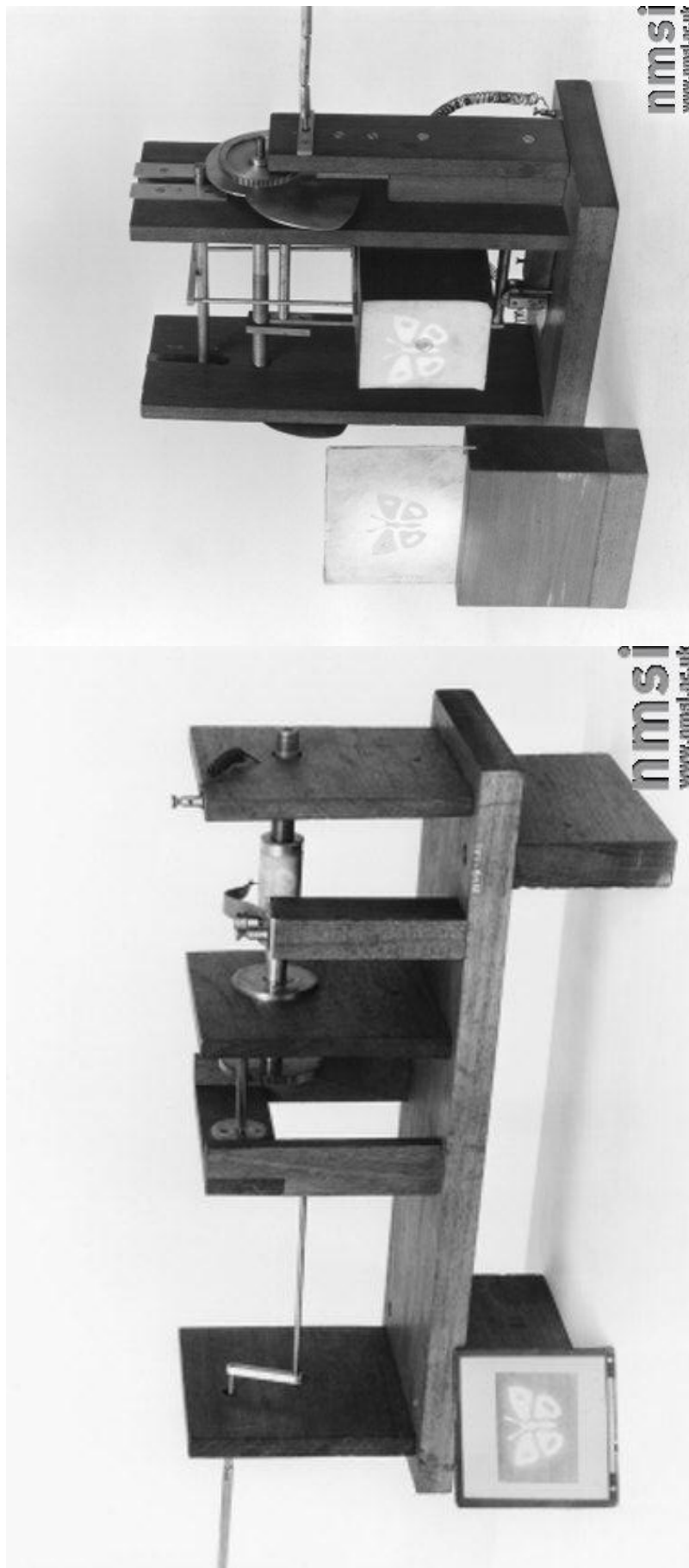
Picture source:  
 Breguet, M. A., "Le  
 Photophone de Bell", *Journal*  
*de Physique Théorique et*  
*Appliquée* . Vol. 9, Iss. 1, 1880,  
 369-375, 370.





**Figure 2.4**  
**Top left:**  
 A Robida (1893) Le Vingtième Siècle *The Twentieth Century*  
**Top right:**  
 A Robida (1893) Le Vingtième Siècle *The Twentieth Century*  
 The home theatre by Telephonoscope  
**Bottom left:**  
 A Robida (1891) Le Vingtième Siècle - La Vie Électrique *The Twentieth Century: The Electrical Life*





**Figure 2.5 Shalford Bidwell's transmitter (left) and receiver (right) with simple butterfly image to be scanned and displayed. 1881**

Picture source: Science Museum/Science & Society Picture Library Picture refs: 10439605, 10439605

PAUL NIPKOW IN BERLIN.

Elektrisches Teleskop.

Fig. 1.

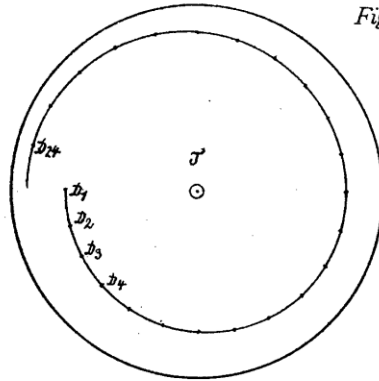


Fig. 2.

Station I.

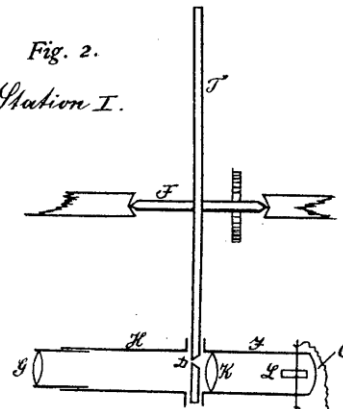
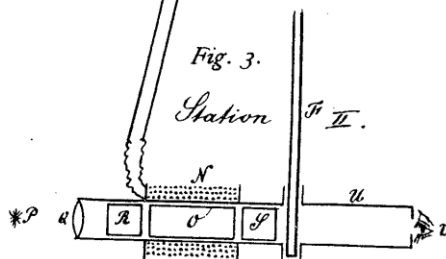


Fig. 3.

Station

II.



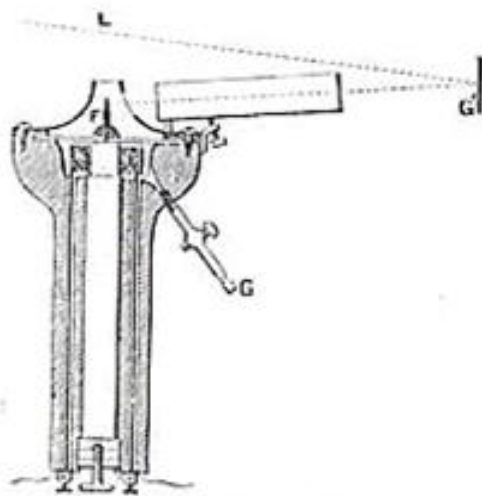
Zu der Patentschrift

№ 30105.

PHOTOG. DRUCK DER REICHSDRUCKEREI.

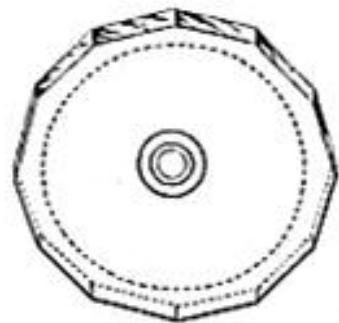
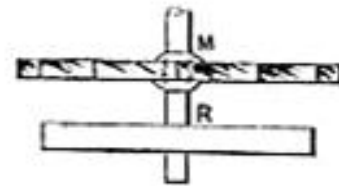
Figure 2.6 Nipkow's disc

Picture source: German Patent Office archive. German Patent No. 30105, 1884.



L, Linette; F, Funne; G, gas; G, Glass.

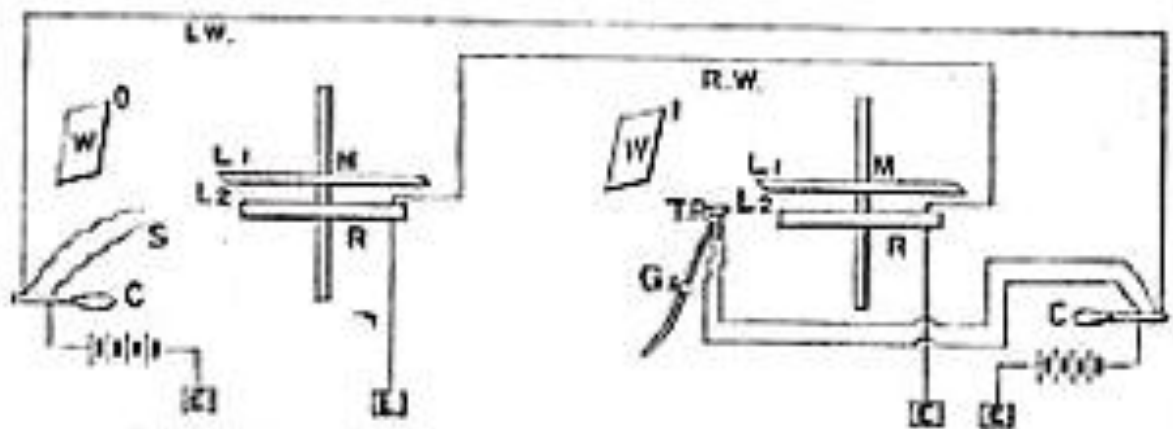
FIG. 1.



M, mirrors; R, regulator.

50 revolutions per second; 200 glasses on the sides instead of 12.

FIG. 2.



L.W., line wire; R.W., regulator wire; L<sub>1</sub>, L<sub>2</sub>, lenses; M, mirror apparatus; R, regulators; G, object; I, image; S, selenium transmitter; C, commutators; G, gas; T.R., telephone receiver; E, earth

FIG. 3.

**Figure 2.7 Weiller's drum scanning system. Top left - manometric light intensity modulator.**

**Top right: multi-faceted drum with incrementally offset mirrors. Bottom: overall scheme.**

Picture source: "Sur la vision à distance par l'électricité French language [On distant vision by electricity]", *La Lumière électrique*, Nov 16, 1889.



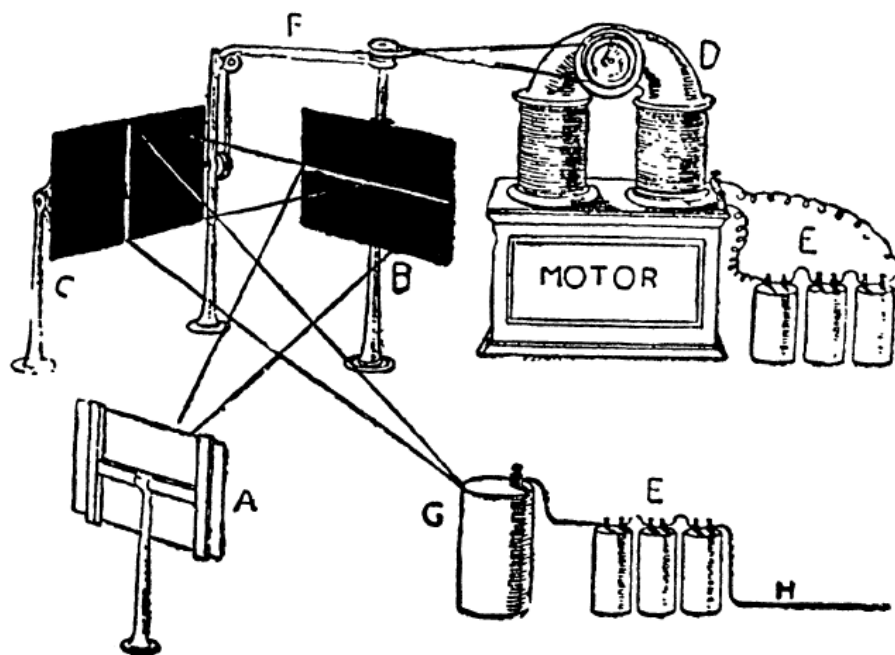


FIG. 1. The Transmitter

*Illustrated London News*

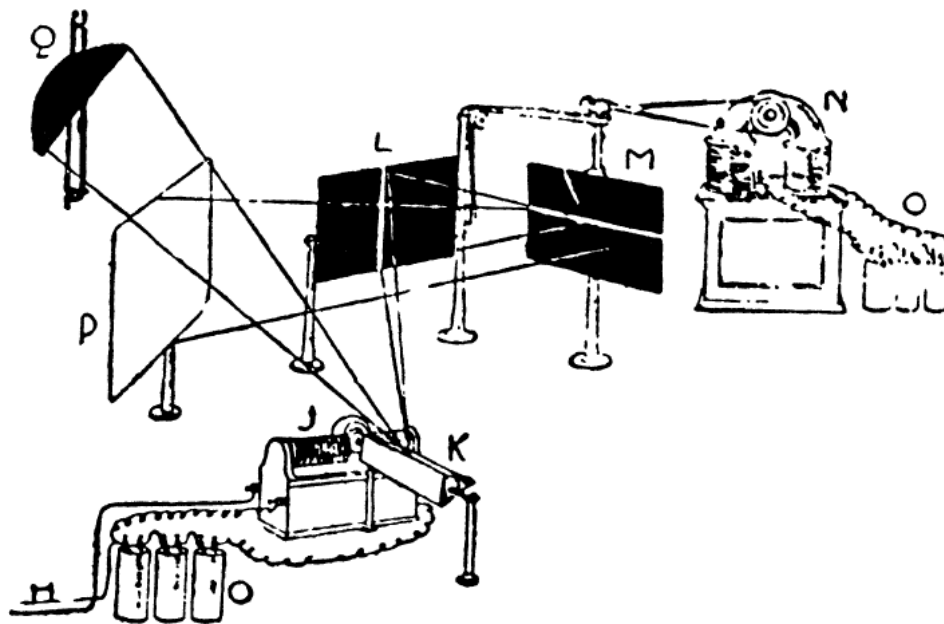


FIG. 2. The Receiver

*Illustrated London News*

**Figure 2.8** Szczepanik's transmitter and receiver.

Picture source: *Illustrated London News*, Apr 23, 1898, 593.

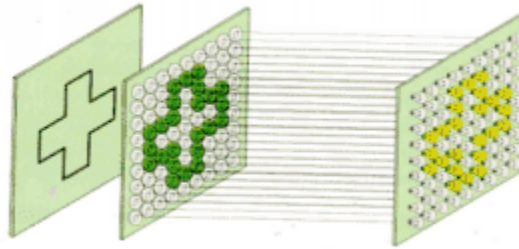


**Figure 2.9 Actual scanned picture sent by Korn's picture telegraphy machine in 1906. It appears to be composed of approximately 120 vertically scanned lines.**

Picture source: *L'Illustration*, Nov 24, 1906.

## **Appendix 2.1 Technical descriptions**

### **2.1a Non-scanning systems**



**Fig 2.10 Non-scanning matrix**

Picture source: Peters, J A History of Television

[http://arantxa.ii.uam.es/~jms/tvd/tv\\_history.pdf](http://arantxa.ii.uam.es/~jms/tvd/tv_history.pdf)

Accessed: 01/28/2011.

An image is focussed on to an array of photo-electric cells (typically selenium in nineteenth and early twentieth century distant vision suggestions), and each cell is individually wired to a lamp at the receiving end. The system does require a common power supply, but conceptually it is a massively parallel non-scanning, continuously operating scheme. Its principal flaw is the sheer number of interconnecting wires.

### **2.1b Nipkow's disc patent**

**Ref: Figure 2.6**

The proposal was to rotate the discs at a constant rate such that the spatial position of the holes remained constant relative to each other. Behind the transmitting end would be a selenium cell, coupled to a light source and a Faraday optical modulator via a telegraph line excited by a series connected battery. At the receiving end, a Faraday modulator would enable the strength of incident light to be varied according to the applied electrical current. The incident source of light would have to be filtered to produce one polarisation using a Nicol prism, the light then being passed through a Faraday magneto-optical cell comprised of a coil of wire around a suitable block of flint. Such an arrangement turns the plane of polarisation of light according to the strength of the coil current. The outgoing light is then analysed by a second Nicol prism optical polariser to block or pass the polarised light according to its polarisation. As the discs turn, the selenium cell explores the incident scene via the

series of holes and this action produces a varying current in the receiving coil of the Faraday modulator, which in turn varies the plane of polarisation of the incident light. Due to the action of the polarisation analyser the out-going light will respond in amplitude in sympathy with the incident light falling on the selenium cell. The transmitted image will be reconstructed by virtue of the receiving spiral of holes exploring the out-going light beam.

### **2.1c Weiller's drum**

**Ref: Figure 2.7**

Assuming the drum to be mounted horizontally and rotating steadily (see Figure 2.7) an incident spot of light onto the drum would produce a reflected spot with a horizontal movement (a line) by virtue of the rotation of the drum. Given the increasing tilt of each successive mirror, each individual line would be displaced from its predecessor. In this manner a regular rectilinear pattern of lines repeating a rate determined by the speed of the drum's rotation was thus created. Unlike Nipkow's Disc which produces curved scanning lines, Weiller's Drum created a perfectly straight scanning geometry in both horizontal and vertical planes.

### **2.1d Szczepanik's scanning mirrors**

**Ref: Figure 2.8**

As with Nipkow's Disc and Weiller's drum, Szczepanik's system proposed using the same mechanical scanning system for both pick-up and receiving. Also in common with all the proposals of the period, selenium was the de-facto light sensitive element at the pick-up end, but Szczepanik employed a novel method to overcome the well-known slow response speed of the selenium cell. The idea was to use a rotating pair of circular concentric brass rings with a layer of selenium between the two. By concentrating the light on one part of the assembly, a new section of the sensitive selenium cell would be continually exposed, thus mitigating the tardy recovery of the cell to illumination. His display system utilised an incandescent lamp whose instantaneous brightness was determined by a progressive shutter driven by an electromagnetic controlled by the current strength determined by the instantaneous illumination received from the selenium cell at the pick-up end.

## **Chapter 3.**

### ***Spinning Discs and Revolving Mirrors – the Future of Television is Mechanical***

#### ***3.1 Introduction***

In Chapter 2, I established that by the beginning of the twentieth century there were clear concepts about how a ‘seeing at a distance machine’ might work, but little idea about what such a device could be used for beyond adding pictures to telephony. The notion of broadcasting sound to a wide audience, whilst in existence in the form of wired telephone systems such as the Paris théâtrophone, was not well known, and certainly not commonplace. Although wireless broadcasting of sound was technically possible by 1906, it would not become a mainstream commercial proposition until the mid-1920s. In 1925, a viable system of television was still elusive, either wired or wireless, but experimentation amongst inventors and scientists was gaining momentum, with the mainstream work being based on proposals from the late nineteenth century. Virtually all of these schemes about how to actually realise television in practice were based on a hybrid of electrical and mechanical technologies, usually referred to as ‘mechanical’ or more precisely ‘electro-mechanical’. In this chapter, I will describe the development of electro-mechanical television post Great War through to the successes of the mid 1920s and onwards into the early 1930s. It was this latter period that can be described as the ‘heyday’ of the electro-mechanical era of television, when the technical direction for television appeared to be set and ‘uses’ for the technology found.

Although potential markets had been identified, who would be the end users? Would the wireless listener want to watch pictures associated with the sound? Was there really any chance of the telephone user wanting to see images of the other party? Were the inventors of the new technology of television unconsciously targeting people with the same outlook as themselves – those essentially curious about the science, engineering and technologies behind the idea – or was there an assumption on the part of the inventors and their backers that there had to be a use and an enthusiasm for such a concept from the general public? This leads to the more

general question of whether inventors and engineers design, and ultimately produce machines and inventions which they themselves would use, without any clear insight as to who the users would be, or even what the product might be used for. The process, sometimes referred to as the configuration of users by designers, is not limited solely to identifiable inventors or designers, but also on organisational constraints and feedback from potential users.<sup>210</sup> At a time when radio was itself still gaining traction as a broadcast medium, the concept of television was about to be added, even though the reality of the initial demonstrations seen in public and reviewed by journalists were not showing the same immediate entertainment value as sound wireless had done.

This period can never be described as ‘the first television boom’, as some writers have attempted to describe it, because the take-up by the public was so small, but it is significant, as it shaped expectations and encouraged commercial interest in television generally.<sup>211</sup> The domestic adoption of the technology in Britain at the peak of its popularity was at the most only in the region of 3,000 to 5,000 receivers,<sup>212</sup> whilst in the United States, the figure was higher but hard to quantify, although a figure of 25,000 has been claimed.<sup>213</sup> Attempts to develop the technology were widespread, occurring in most developed countries and several names were well known in their respective countries, especially those of inventors John Logie Baird in Britain and Charles Francis Jenkins in the United States. The print media’s initial fascination with the idea of television in the United States, Britain, France and Germany did not translate into equipment purchases in any significant numbers, and the boom hoped for by inventors and investors never materialised.

I will examine this first period in television, and the developments leading up to it, by studying three little known representative narratives of the history of electro-mechanical television. These narratives, two from Britain and one from the United

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<sup>210</sup> Oudshoorn, *How Users Matter*, 8-9.

<sup>211</sup> Udelson, *Great Television Race*, 50-78, Chapter 3 The Great Television Boom; Wieten, “Television’s false dawn”, 210. Both describe the ‘television boom’ of the late 1920s and early 1930s.

<sup>212</sup> Norman, *The Story of British Television*, 92.

<sup>213</sup> Wieten, “Television’s false dawn”, 225, Note 8.

States, examine how the ideas of electro-mechanical television were propagated and how they appeared so rapidly and simultaneously across the world. This limited deployment of electro-mechanical television in many countries peaked and then declined rapidly, at about the same time, ending around late 1934 or early 1935. Any kind of instantaneous ‘distant vision’ system, no matter how inadequate, possessed a huge curiosity value, at least for a year or two after its appearance, but it was not sustainable. Once this curiosity had been satisfied, could electro-mechanical television systems have ever had a future in any application? I believe that they might have, if newer electro-mechanical technologies had been adopted. I will show that the reasons for commercial interest in the technology were diverse and not limited to ‘wireless with pictures’ in the home environment, and that many approaches were actually tried. Other potential applications included uses in the cinema, picture phones (telephones with pictures) and a few military applications such as aerial reconnaissance and remote guarding. The usual conclusion to be drawn is that the popular early electro-mechanical methods as developed were inadequate for virtually all potential uses; however, I will show that at least one pocket of electro-mechanical television excellence could have prospered: a British cinema television system commonly referred to by the name of the company which developed it: Scophony. By 1939, the technology was working well and being deployed in cinemas, but World War II closed down developments.

In the first part of this chapter I will briefly review the rise of sound broadcasting, telephony and cinema across the world, and then consider the position of the development of electro-mechanical television as of the mid 1920s set against these influential technologies. The many individuals and companies active across the world in the race to achieve success with the technology used key information which appears to have been spread largely by a few (around a dozen) popular science publications and technical journals. Almost all of this development work was initially predicated on Nipkow’s disc method, but with a few favouring Weiller’s drum, or Szczepanik’s mirror techniques, and this is clearly seen in the contemporary technical publications.

In the second part of the chapter, I will study the developments of the late 1920s and early 1930s in electro-mechanical television in the United States using the story of a

representative company, Western Television Inc., and its founder, inventor Ulises Armand Sanabria. The narrative begins with a young man successfully developing a Nipkow disc based television system, and then founding a company to exploit the technology – a very similar tale to that of John Logie Baird in Britain. Sanabria's company needed to make money quickly to stay in business and this resulted in the rapid deployment and sale of hardware to address the 'wireless with pictures' model of television. This market, with its potentially huge demand for consumer receivers, was by far the most favoured choice amongst the electro-mechanical television pioneers. As with all of the other companies pursuing this approach, the relatively poor image quality led to its downfall, but Western Television was arguably the most commercially successful of all the electro-mechanical television companies. The narrative of Sanabria and Western Television, when compared to the mass of material about Baird and his contemporary companies, yields only a sketchy account of electro-mechanical television activities in a small entrepreneurial television company. However, as a previously unexamined example, it yields new insights of how such a company fared in the electro-mechanical era of television's development, without the highly polarised and lengthy debates which surrounds the narrative of Baird.

In the third part of this chapter I will focus on a large, well established, British company attempting to find an application for television that it could make its own and then capitalise upon. The company to be described is Marconi's Wireless Telegraph Company Ltd., (MWTCO. Ltd.); then a major force in world telecommunications, both technically and commercially, although shorn of its interests in consumer wireless sets. Their approach was not based on the 'wireless with pictures' broadcast to the home model, but on creating forms of high speed facsimile, non-Roman script written text transmission, and the cinema presentation of television pictures. These focused marketing targets were felt by the company to be more amenable to defensible patent coverage, and ultimately in creating profits. As with Western Television Inc., the narrative surrounding the electro-mechanical television activities of this company have never had much exposure, and yield some new insights into large wireless company thinking on how to approach the new technology. The company's approach did have some potential, but once again the poor image quality restricted adoption and commercial opportunities.



In the final part of this chapter I will examine another relatively unknown organisation, a small British company called Scophony Ltd., which was pursuing a radically different electro-mechanical television technology. Many of their unique technical methods continued to a flourish in specialist applications and some are still in use today in applications such as document scanners and specialist displays applications. The Scophony inventions in electro-mechanical television did not rely solely on the 'traditional' methods associated with discs, drums or mirrors, but added ingenious electro-optical techniques to them which dramatically improved the picture resolution and overall quality. By the outbreak of World War II, the company had achieved a good level of technical performance for entertainment purposes in the cinema using essentially electro-mechanical technology. I will examine how they achieved this, and how the known deficiencies of electro-mechanical television technology in the early 1930s influenced the direction of the company.

I will conclude that with the exception of the case of Scophony, all of the companies developing electro-mechanical television had followed the same basic technical path, even if their target markets varied. This path was to develop the late nineteenth-century concepts for 'distant vision' machines which could, by the late 1920s, actually be made to work (and relatively quickly and cheaply) using current electronics and wireless technology. Scophony's technology – based on new electro-mechanical techniques – could have resulted in a very different developmental model for television to the home and in the cinema. There is a narrow date range, somewhere between 1934 and 1935, when the enthusiasm of investors and inventors for electro-mechanical television technology effectively collapsed throughout the world. There were three major reasons for this: firstly, the difficulties of achieving adequate picture fidelity for almost any application with electro-mechanical technology; secondly, the promise being shown by the all-electronic systems (I will cover this in Chapter 4); and thirdly, difficulties with securing patent cover for systems based on nineteenth-century ideas. With just a few exceptions, the electro-mechanical era of television was all but over by the beginning of 1935, but this does not mean that the technology could not have been developed further, and formed the basis of a viable, but different, television system for broadcasting, or for use in the cinema and even for point-to-point communications.

## **3.2 The maturing of sound broadcasting, telephony and the cinema in the early 1920s**

### **3.2.1 The rise of sound broadcasting**

There is much debate amongst historians about the reasons for the rise of sound broadcasting in the first 25 years of the twentieth century. The disparity at the root of this debate is largely due to national differences amongst the three first-wave early adopter countries of the United States, Britain and Germany. In these three countries the starting conditions, the cultural back-drop and the political view of broadcasting were quite different, and the regulatory systems controlling sound broadcasting evolved to reflect these differences. The actual concept of broadcasting was not new; there were late nineteenth-century pre-cursors to sound broadcasting in Europe and in the United States based on telephone technology. Wired systems such as the French théâtrephone,<sup>214</sup> the very successful Hungarian telefon hirmondo,<sup>215</sup> and in Britain the moderately successful electrophone, explored some of the possibilities of one-way simultaneous communication to a mass audience.<sup>216</sup> Speculation on future developments in this medium was fed by author Arthur Mee writing at length in *The Strand Magazine* on the ‘pleasure telephone’ describing many novel uses for such systems.<sup>217</sup> In North America there were also ‘wireless’ systems based on the electromagnetic induction and ground conduction work of inventor Nathan B Stubblefield in the 1880s,<sup>218</sup> and more importantly, by Canadian engineer Reginald Fessenden using wireless electromagnetic waves in 1906.<sup>219</sup> Wireless, in its usual sense of using electromagnetic waves, whether for telephony or telegraphy, was originally a point-to-point communication process, and how broadcasting was added to wireless communication is not completely clear.

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<sup>214</sup> Bertho-Lavenir, “Technical Innovation and spectacle in society”.

<sup>215</sup> Denison, “The Telephone Newspaper”.

<sup>216</sup> “Music, singing and dialogues”, *The San Francisco Call*, 1898.

<sup>217</sup> Mee, “The Pleasure Telephone”.

<sup>218</sup> Hoffer, “Nathan B. Stubblefield”.

<sup>219</sup> Belrose, “Fessenden”.

Historians such as Susan Douglas and Hugh Slotten emphasise different aspects in the rise of broadcasting in the United States. Douglas sees the rise as being an effect of government regulation to control ‘amateurs’ and the commercialising of their activities,<sup>220</sup> whilst Slotten suggests that it was simply the desire of commercial interests to sell advertising.<sup>221</sup> British historian Asa Briggs is less certain in his analysis of the reasons for the rise of broadcasting in Britain. He recounts similar instances of pressure from radio amateurs such as occurred in the United States, but he also notes the influence of British wireless set manufacturers, although the earliest sets were home constructed.<sup>222</sup> In Germany, the rise was dominated by government control which, given the German political turmoil of the 1920s, rapidly became a potent tool for political propaganda which is a self-evident reason in itself. The second wave of the take-up swept rapidly across the rest of North America and Continental Europe, the USSR, Japan, India and even Ceylon. By the late 1920s, the deployment of consumer receiving apparatus was becoming widespread across the world.

### **3.2.2 The maturing of telephony**

Telephony across the developed world in the 1920s was still primarily a tool for point-to-point communication in commerce and government. Domestic installations were confined to the urban middle classes and rural dwellers such as farmers. Even amongst these groups, take-up was patchy. Despite this, the public’s knowledge, use and understanding of the technology were widespread. Adding pictures to the existing sound only point-to-point communication was certainly of potential commercial interest to large telephone companies, keen to maximise sales of new instruments and services, but there is no evidence that there was much desire for a ‘telephone with pictures’ amongst the actual users of the technology, be they private subscribers, business or government agencies. Even after the emergence of wireless broadcasting, there were some attempts (beyond those of the théâtrophone and telefon hirmondo), made to provide similar broadcasting services across wired

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<sup>220</sup> Douglas, *American Broadcasting*, 298-302.

<sup>221</sup> Slotten, *Radio's Hidden Voice*, 100-101.

<sup>222</sup> Briggs and Burke, *A Social History of the Media*, 153.

networks, but the take-up was tiny. An exception was the wired radio relay systems (known as relay exchanges in Britain), popular in some large cities in Britain from the late 1920s, and also in the USSR.<sup>223</sup> These were dedicated wired systems which were not part of the telephone system and carried relays of broadcast programming – in effect ‘wireless radio’ broadcasting by wire. The telephone itself thus remained a separate point-to-point, personal communication system and was restricted in any deployment as a broadcasting system. In Britain, how the relay exchanges operated was controlled by law after the formation of the BBC, with specific controls in place to protect the Corporation’s monopoly of broadcasting.<sup>224</sup>

### **3.2.3 The beginning of the cinema boom**

By the mid-1920s the cinema industry had reached the first stages of its boom period, with audiences recorded in the millions and attendance by people across the developed world commonplace and regular. In black and white, but with experimental ‘talkies’ adding sound to the existing pictures, the acceleration in the industry’s success seemed to be assured. By the very nature of the technology, a film process involves many stages in production, duplication and distribution, so the entertainment and information presented in the cinema was in no way ‘live’, the action having typically been recorded many months or even years previously. It was possible to have simple features on local screens in days, but these were far from the polished, widely distributed works of the large studios which took much longer to create. In this respect the cinema lacked the immediacy of the wireless and telephony, but as an entertainment medium it excelled. Apart from a tendency to flicker, the technical quality of the large, resolute, bright images was excellent. Furthermore, due to the increasing prowess of the film makers, the industry was producing excellent mainstream entertainment at an affordable price. In terms of pictures (both technically and artistically) any television system would be in competition with a hugely successful and booming rival. Television’s prime differentiator in concept was that it could be ‘live’, without having to wait for all the

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<sup>223</sup> Coase, “Wire Broadcasting”. Describes the evolution of ‘wire broadcasting’ in Britain and how it influenced the development of wireless broadcasting.

<sup>224</sup> Briggs, *The Golden Age of Wireless*, 331-33. Outlines the background to the ‘problem’ (from a BBC perspective) of the relay exchanges.

long-winded processing and distribution associated with film technology. Furthermore, in principle at least, television could be installed and used domestically, a much more difficult and expensive proposition using film projection.

### **3.2.4 Early 1920s developments in electro-mechanical television across the world**

Against this back drop of rapidly growing sound broadcasting, expanding telephony and booming cinema, the idea of television reappeared in the early 1920s. In the wake of the Great War, with engineers and scientists having available to them the newly developed wireless technologies of amplification and oscillation, new entrants to the quest for television appeared. Hungarian inventor, Dénes von Mihály is an example of this new intake of researchers and inventors in to the field, not only amassing many patents in quite a short period of time, but taking his ideas through to practical realisation with demonstrable results. As a young man in the early 1920s, he quickly adopted the then new thermionic valve technology of the wireless industry, using amplifiers in a scanning technique based on Leblanc and Szczepanik's vibrating mirror scanners previously described in Section 2.5.2.<sup>225</sup> Mihály's work was covered well in contemporary technical journals and magazine articles, presenting his amalgam of mechanical scanning with thermionic amplification and signal handling as a new approach.<sup>226</sup>

Mihály was in the vanguard of realising the possibilities of this marriage of the old and the new, using new technology to make the old late nineteenth-century ideas for a 'distant vision' machine actually work. His machine, known as the telehor (see Figure 3.1), was very complex, but it did work, at least in terms of silhouettes.<sup>227</sup> What was important about this work was the application of thermionic amplification techniques to mechanical scanning which demonstrated new possibilities, beginning a new direction in television research and invention. In order to pursue his work commercially, Mihály moved from his native Hungary to Germany, founding Telehor AG and changing technical direction away from vibrating mirrors towards

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<sup>225</sup> Shiers, *Bibliographic Guide*, 19.

<sup>226</sup> Gradenwitz, "The Mihály television scheme".

<sup>227</sup> Burns, *Television*, 243.

Nipkow discs.<sup>228</sup> His work failed to develop much further than the transmission of silhouettes, but his early successes attracted attention from investors and entrepreneurs, eventually leading to the formation of Scophony Ltd. in Britain, covered in Section 3.5.

With wireless broadcasting developing very rapidly throughout the world in the early 1920s, the new interest in the idea of marrying sight to sound was similar to the initial interest of the late 1870s in marrying ‘distant vision’ to the then very new telephony. The converse process of adding sound to sight was happening in the cinema with the advent of the ‘talkies’ in the late 1920s, so why not add pictures to wireless broadcasting too? This ‘obvious’ proposal may be evidenced by some of the proprietary names given to a television system, such as movie pioneer Charles Francis Jenkins’ ‘radiovision’, Mihály’s ‘tele-cinema’ and the Westinghouse corporation’s ‘radio movies’ of the late 1920s.<sup>229</sup> The renewed interest in the technology of television was not just amongst individual inventors, as was the case at the beginning of the century; it had caught the attention of established wireless manufacturers. With activity growing again, the ‘lone inventors’ were soon supported by small numbers of engineers and scientists, backed by commercial capital along the Edison model.

Besides Mihály, there were around a dozen others all following a similar path, but largely having a more commercial view with regard to the exploitation of the invention, compared to their pre-Great War predecessors. In 1925, there were three leaders in field: in Britain there was entrepreneurial engineer, John Logie Baird; in the United States, in Chicago, Ulises Armand Sanabria, a young man straight out of high school and in Washington DC, Jenkins with his radiovision.<sup>230</sup> The three named above, plus perhaps Mihály, can be shown to have been the most successful in the early attempts to perfect and commercialise the technology of electro-mechanical television, but there were others, including scientists in the USSR, Germany, France

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<sup>228</sup> Gradenwitz, “Mihály's Tele-cinema”.

<sup>229</sup> Jenkins, “Radio Vision”; Gradenwitz, “Mihály's Tele-cinema”; “Radio Movies Demonstrated”.  
*Science and Invention*.

<sup>230</sup> Herbert, “Charles Francis Jenkins”.

and Japan.<sup>231</sup> In addition to the small, focused companies set up by such individuals as Baird, Sanabria and Jenkins, the large telephone and wireless companies were beginning to take more interest in what might be possible, spurred on by possible new commercial opportunities. Their large corporate research laboratories were in direct competition with the much smaller, and much more focused, new companies predicated solely upon television.

In the United States, the General Electric Company (GE), the Radio Corporation of America (RCA), American Telephone and Telegraph Company (AT&T) and the Westinghouse Electric and Manufacturing Company all joined the race, whilst in Britain MWTCO. Ltd., and His Master's Voice Ltd. (HMV) were the principal large companies taking an active interest in developments. Some of these companies publically fronted their television work in magazines and journals with their leading scientists in the field: AT&T had Dr. Herbert Ives and GE had Dr Ernst Alexanderson. Other individual figures emerged soon after the first forays by Baird, Jenkins and Sanabria, such as American engineer Hollis Semple Baird (no relation to the British Baird), scientist Rène Barthelmey in France, physicist Baron Manfred von Ardenne in Germany, Lev Sergeyevich Termen<sup>232</sup> in the USSR, and electrical engineer Kenjiro Takayanagi in Japan. Termen's work is novel in that it was sponsored by the Soviet state and was instigated as a means of 'remote guarding', a 'distant viewing' of stretches along the long Soviet border. This was one of the few military applications proposed for television, the other being the British Baird's 'seeing in the dark' using infra-red ray illumination, his 'Noctovision'.<sup>233</sup> All of these individuals and companies were creating their own versions of electro-

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<sup>231</sup> The actual number of individuals interested in this field by 1925 is impossible to quantify as the new field of wireless broadcasting had produced large numbers of experimenters, radio amateurs and inventors with at least a passive interest in television. Patent activity is only a rough guide, but in 1925 there were 36 electro-mechanical television related patents granted. See: Shiers, "The Rise of Mechanical Television". In Figure 1, Shiers also records many of the individuals involved in the period to 1925, with scientists such as August Karlous of Germany, Alexandre Dauvillier of France and A A Tschernyshev in the USSR.

<sup>232</sup> Lev Sergeyevich Termen is better known in the West as Leon Theremin, the inventor in the late 1920s of the electronic musical instrument known as the theremin.

<sup>233</sup> Kamm and Baird, *John Logie Baird*, 81-82.

mechanical television, and all were based on spinning discs or drums and/or oscillating mirrors, although von Ardenne and Takayangi were also experimenting with cathode ray tubes. There were more, probably in the region of dozens of individuals and a dozen or so companies, but it is very difficult to produce firm figures.

Other than by third party publications in technical wireless magazines and reports in more general publications such as *Electrical Review*, there appears to have been little direct international communication between scientists and engineers in the field in the 1920s. In Britain, the spread of information about developments in television was facilitated by the formation of the Television Society in 1927, publishing its monthly journal *Television* beginning in March 1928. As a new specialist journal, but enjoying a claimed initial circulation of 10,000 copies, the publication was widely read, even if the membership was probably comprised largely of amateur wireless enthusiasts.<sup>234</sup> The society was influential in the early development of television in Britain, but some regarded it as the Baird 'house magazine'; reducing its authority to speak impartially.<sup>235</sup> Having the eminent electrical engineer and physicist, Prof. Sir J A (Ambrose) Fleming as its second president would have offered considerable credibility, but with Baird as the first and only honorary fellow and Sir James Percy, a Baird company director, as vice president, the Society does appear to have been dominated by Baird followers. This was reinforced in early 1929 when Sidney Moseley, owner of the publishers of the Television Society journal, the Television Press Ltd., became a Baird company employee.<sup>236</sup> Whilst Baird dominated press coverage in Britain, many of the major wireless companies such as MWTC., initially preferred to remain secretive about their work, not needing to attract publicity to produce funding. In the United States most companies as well as individuals sought publicity, each trying to better the others for headlines and press attention.

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<sup>234</sup> Ibid., 101.

<sup>235</sup> Ibid.

<sup>236</sup> Ibid.



Whilst the ‘how’ of the technology fascinated enthusiasts, several articles, letters and cartoons appeared in periodicals, newspapers and journals in the early 1920s, with writers and artists musing over ‘what’ television might be used for.<sup>237</sup> Most potential uses were just speculative, but others examined the related technical issues surrounding existing attempts by scientists such as Alexanderson and Ives. Did the purely speculative and science fiction based publications, such as those of American editor/writer/inventor Hugo Gernsback, lead interest in the idea of developing working electro-mechanical television, or did they follow the technical lead of others? It is likely to have been both, one feeding from the other. Gernsback’s magazines, such as *The Electrical Experimenter*, had certainly featured television many times by the early 1920s, often with imaginative front covers as illustrated in Figure 3.2. Such magazines as Gernsback’s were widely read in the United States with a claim to being ‘The largest circulation of any electrical publication’ on the front cover, and ‘proven’ by an article evidencing a circulation of at least 100,000 copies.<sup>238</sup> Gernsback also began broadcasting television himself using his own station, WRNY, in New York.<sup>239</sup>

The sharp rise in interest amongst inventors and scientists in the technology of television in the early 1920s occurred in parallel with the rise in wireless (sound) broadcasting, yet there was also corporate interest in applications relating to adding pictures to telephony, and in presenting live events in cinemas.<sup>240</sup> Broadcasting came to dominate the potential applications of television, as companies awoke to the possibilities of the mass market for consumer receiving apparatus. The market was similar to, but potentially even larger, than the existing one for sound receiving sets, if there really was a viable and popular use for the technology. I will next examine a wholly representative example of the rise and fall of an electro-mechanical television company, primarily pursuing the broadcasting opportunities of the technology.

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<sup>237</sup> “Football by Wireless”, *Hastings and St Leonards Observer*, 1924; “Diagnosis by Radio”, *Science and Invention*; Pankhurst, “Pressing problems”, 165. Describe speculative uses for television.

<sup>238</sup> Gernsback, “Vol. 6, No.1”, 16, 17 and 50. An article, entitled: Vol. 6, No.1, fancifully written by the magazine ‘herself’, recounting the rapid rise to success of *The Electrical Experimenter*.

<sup>239</sup> Massie and Perry, “Hugo Gernsback”, 276-277.

<sup>240</sup> Burns, *Television*, 206-211.

### **3.3 Making the most of just a few lines – Ulises Sanabria and Western Television Inc., 1926 – 1934**

#### **3.3.1 Background and early work**

Sanabria's Western Television Inc. was a successful early 1930s company in the field of electro-mechanical television. In commercial terms it was more successful than the well documented British inventor, Baird, and his original company, Television Ltd., but today, it is almost completely forgotten. Little is known about Sanabria himself beyond a very short self-penned account of his life and television activities, but this tends to concentrate on his post-World War II businesses rather than the electro-mechanical developments of his youth.<sup>241</sup> From this brief document a little of his background can be deduced, but no real clues appear about his early work on television that produced his first commercial backer. Born in Chicago in 1906, Sanabria usually described his background as being 'typically American', having antecedents of many nationalities.<sup>242</sup> His paternal heritage was solidly Puerto Rican and ultimately of Spanish descent. Raised in the Oak Park district of Chicago, Sanabria's education began at the Nathaniel Hawthorne Grammar School and concluded at the River Forest Township High School, both being in the same district of Chicago.<sup>243</sup>

Only very sketchy accounts of Sanabria's early television work exist. In his very brief auto-biographical notes written in 1966 he states:

Hired by Hearst Newspapers to direct project to create television in six months during last year of high school because television inventions appealed to the publisher's technical advisers.<sup>244</sup>

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<sup>241</sup> Sanabria, "Personal memories".

<sup>242</sup> Martinez, *Puerto Ricans in Chicago*.

<sup>243</sup> In the United States, the designation 'Grammar School', remains little used but implies an elementary school with pupils up to the age of about age 14. Such schools are now more commonly known as a 'Junior High'.

<sup>244</sup> Martinez, *Puerto Ricans in Chicago*.

No date is given, but assuming that he left high school at the age of 18, that would suggest that his television work for Hearst Newspapers began sometime around 1924 and he is certainly recorded in the 1924 class year book of the River Forest Township School.<sup>245</sup> How and why he made the leap straight into television research remains unknown, but it is likely that he was influenced by the many speculative technical magazines in the early 1920s covering the field of television such as those of Gernsback.<sup>246</sup> His auto-biographical notes continue, as he recalls developments in 1926:

I believed that light could directly affect electrons in motion, but soon realized that I was observing the photo-electric effect. My staff and I developed long column gas discharge lamps using both cold and hot cathodes and many types of alkali metal cells. I became familiar with glass blowing tools, materials and techniques.<sup>247</sup>

Using the word ‘staff’, suggests that the funding from Hearst Newspapers was still in place as a company with no sales requires investment to be able to hire employees. Technically he appears to be following the photoemissive path for the pick-up device rather than the photoconductive approach based on selenium, which was already known to be too slow. Such photoemissive devices were known to be promising for television work by the mid-1920s, but the problems of fabrication and low sensitivity led to many difficulties requiring long and patient research. For the receiving display the auto-biographical note above infers that he is using the then ‘standard’ gas discharge lamp (neon) as a modulating light source. No mention of Nipkow discs is made or inferred in these notes, but he does speak of ‘precision mechanical devices’.<sup>248</sup> From this it can probably be assumed that his whole system proposal was firmly based on the Nipkow disc idea, as by the 1920s there had been frequent reports about the technique in the technical press about this long standing idea – the

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<sup>245</sup> 1924 Year Book, Oak Park & River Forest High School Alumni Association. Chicago. Via e mail, from Maureen Kleinman of the Oak Park & River Forest High School Alumni Association, 04/17/2009.

<sup>246</sup> Ashley and Lowndes, *The Gernsback Days*.

<sup>247</sup> Martinez, *Puerto Ricans in Chicago*.

<sup>248</sup> Ibid.

patents for which had expired decades earlier. A letter, written in 1984, by William N Parker (a University of Illinois student in the mid-1920s) to an electro-mechanical television enthusiast, yields some clues about the origin of Sanabria's photoemissive cell technology.<sup>249</sup> In the letter, Parker recalled that he was involved in work at the University of Illinois, undertaken by a researcher there, Lloyd P Garner:

A vital part of the television system was the bank of four large photoelectric cells that picked up the light reflected from the flying spot on the subjects (sic) face. These cells were made by Lloyd P. Garner at night when no one else was in the Physics Lab.<sup>250</sup>

Garner eventually became a Sanabria employee after first being a partner in a small enterprise called GM Scientific Co., run by him and fellow graduate student, A. J. McMaster. This company supplied photoelectric cells and other devices to universities and companies engaged in television and 'talkie' research for movies.<sup>251</sup>

The other item of note in this passage is the reference to 'flying spot'. This approach to the pick-up side of television was new and only patented in 1926 by Baird in Britain where it was known as the 'spotlight method' and in the United States by Frank Gray of the Bell Telephone laboratories in 1927.<sup>252</sup> The technique still used a Nipkow disc, but the photo sensitive device behind the disc called for by Nipkow is replaced by a bright light source. The scene to be televised is illuminated by a rapidly scanning spot of light and the light reflected by the scene is picked up by a bank of photocells (see Figure 3.3). It proved to be a much more sensitive method as multiple photocells could surround the scene and receive much more light than if one such device had been placed behind the Nipkow disc. It also dramatically reduces the intensity of the incident light on a subject, something that was proving to be a major

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<sup>249</sup> The letter was addressed to electromechanical television enthusiast Peter Yanzcer. See: Yanzcer, "Ulises Armand Sanabria".

<sup>250</sup> Parker, "Early Chicago Television".

<sup>251</sup> Fast photocells were needed for sound on film systems where the sound is recorded optically alongside the picture information.

<sup>252</sup> Baird, "Apparatus for the Transmission of views, scenes or images to a distance", Patent No. 269 658; also see Abramson, *Zworykin*, 59.

problem with the traditional Nipkow technique. A fundamental lack of sensitivity was one of the biggest issues facing designers of electro-mechanical pick-ups and there were few possible solutions. Despite its advantages, the technique suffers from a major limitation in that only close-ups and medium shots can be televised and then only in darkened conditions. This precluded outside daylight television and long shots of anything more than a few feet from the scanner head. The technique is explained more fully in Appendix 3.1. There is also another claim to the idea by American company Electrical Research Products Inc. with patent applications in the United States and Britain.<sup>253</sup> The patents seem to have been largely disregarded by companies working on television as almost all of the electro-mechanical pick-up designs of the late 1920s and early 1930s used the technique and no records of royalty payments have been noted in any sources consulted.

By the late 1920s, other television researchers were beginning to experiment with an alternative mirror drum scanner technology to replace the Nipkow disc at the pick-up end of the television system. Parker seems to suggest that Sanabria's system in 1926 might have been based on the very new lens or mirror drums with this description in his 1984 letter:

I, [...] had the good fortune to witness Sanabria's work in June of 1926. The television images were in silhouette and blurred and it was barely possible to distinguish between the image of a person's hand with outstretched fingers and that of a wrench. A rotating drum with lenses was used as a scanner.<sup>254</sup>

The 'drum' mentioned may be an error on Parker's part as Sanabria's systems in photographs, patents and descriptions all show flying spot Nipkow disc techniques. In this same letter, Parker then goes on to stake a claim to the precedence of the television invention made by Sanabria in the foreword to an album of his songs (he was also a composer of music) by quoting the text in verbatim.<sup>255</sup> It states:

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<sup>253</sup> Burns, *John Logie Baird*, 121.

<sup>254</sup> Parker, "Early Chicago Television".

<sup>255</sup> Sanabria followed in his father's musical tradition and also composed music, including the campaign song for the first Eisenhower presidential campaign of 1952. I have been unable to substantiate this claim, but it is possible given the Sanabria family's musical background.

Stories about John Baird preceding either Jenkins or myself are incorrect as to date for we have abundant proof to the contrary. Both Jenkins and myself developed television independently and television is truly an America[n] invention and do not let anyone ever tell you that the Europeans ought to share in the credit.<sup>256</sup>

Exactly where Sanabria stood with regard to his television system's performance relative to his rivals such as Baird and Jenkins around the mid and late 1920s, is not precisely known, and assessment can only be made by a few still photographs, subjective personal accounts and by using technical replicants. Jenkins is known to have only demonstrated silhouettes by 1926, whereas Baird had demonstrated television with half tones from reflected light to a number of witnesses, and in public at Selfridge's department store in London. It is certainly only months that separate all three inventors, with Sanabria and Baird being almost impossible to separate in terms of priority. The significance of Sanabria claiming the invention for America is not only early evidence of the nationalistic race for historical television priority, but of the general problem caused by the key Nipkow disc patents having expired decades earlier. Any attempts at the further patenting of techniques and methods allied to the Nipkow disc would require the citation of prior art which could be detrimental to any claims. Furthermore, the question of precedence had contemporary significance in terms of publicity value. The importance placed on 'being first' is often associated with 'the best' in the minds of potential backers and purchasers.

The next significant quotation from Sanabria's autobiographical notes on his achievements states:

First to produce television using interlaced scanning on January 26, 1926 - financed by Illinois Publishing & Printing Company. Demonstrated successful television to 200,000 people attending Chicago Radio Show from

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<sup>256</sup> Parker, "Early Chicago Television".

October 10th through 17th, 1926 at Chicago Radio World's Fair, Chicago Coliseum.<sup>257</sup>

This is a significant claim, not just because of the demonstration of television, but the mention of 'interlaced scanning'. Interlacing is a versatile technique. It can be used to either reduce visible flicker within a given frame rate, or conversely it can increase resolution without increasing flicker or occupied bandwidth. The technique was an almost zero-cost modification yielding great benefits that could improve any nascent television system dramatically. It is still used in virtually all broadcast television systems, including the current digital high-definition formats. A description of how and why interlacing works, what it is used for and why it is important in television technology is given in Appendix 3.2. The significance of interlacing, so far as the very late 1920s electro-mechanical television systems are concerned, has not been appreciated until recently, but it is becoming accepted as the origin of the method and the appreciation of its technical advantages.<sup>258</sup>

Several television patents before Sanabria's vaguely describe interlacing systems, but his is more explicit. The idea first appears in a British patent in 1915 as part of a complex set of proposals for an electro-mechanical television system described by a British educational missionary to China called Samuel Lavington Hart.<sup>259</sup> This patent does not mention the word 'interlace' but does describe a system of meshed lines which is a form of interlacing. The second, by British inventors, William Stephenson and George Walton, is a very complex concept describing two intersecting discs with spiral slots rather than a spiral chain of holes with a non-sequential method of scanning described.<sup>260</sup> Baird is the first to explicitly describe an interlacing system in his patent of 1925 when he describes an 'intercalated scanning' system, as he termed

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<sup>257</sup> Martinez, *Puerto Ricans in Chicago*.

<sup>258</sup> O'Neal, "Ulises A Sanabria and the Origins of Interlaced Television Images".

<sup>259</sup> Hart, "Improvements in Apparatus for Transmitting Pictures of Moving Objects and the like to a distance Electrically", Patent No. 15,720.

<sup>260</sup> Stephenson and Walton, "Improvements relating to Apparatus for Transmitting Electrically Scenes or Representations to a Distance", Patent No. 218,766.

interlacing.<sup>261</sup> He makes no claims about the technique being used to reduce flicker or increase the picture resolution within a given bandwidth, and it is also an impractical method that he describes, whereas Sanabria's description of three spirals yielding a 3:1 interlace is straight forward and very easy to engineer. One more patent followed that of Baird which could be construed as describing interlaced scanning prior to Sanabria. This was granted to French inventor Marius Latour, who, in 1926, described two separate offset Nipkow discs used to create a single image which, like Baird's proposal, was never reduced to practice.<sup>262</sup> A Sanabria triple spiral disc is shown in Figure 3.4.

It appears that Sanabria had priority in describing a practical technique of interlacing, thereby creating a major advantage for him in Nipkow disc technology with its long expired patent and weak prospects for development. As a technique, it was very simple to incorporate in systems and it gave him a significant practical technical advantage over his rivals. The patent, with its explicit description and drawings of three spirals of holes, suggests a highly defendable invention given sufficient financial and legal backing. With Hearst Newspapers as an investor, it is likely that Sanabria had both available to him to protect his idea. All of his subsequent electro-mechanical television work was based on this triple interlace format and no other company or individual appears to have challenged this patent, including the owner of a slightly later patent belonging to RCA which became very important in later all-electronic television.<sup>263</sup> What is not obvious from Sanabria's interlace patent is what he had actually invented it for. A claim for flicker reduction does not appear, although there is a vague description about bandwidth reduction.<sup>264</sup> In his own description in the patent he claims:

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<sup>261</sup> Baird, "Improvements in Apparatus for Transmitting Scenes or Representations to a Distance", Patent No. 253,957.

<sup>262</sup> Latour, "Improvements in the Transmission of Photographs or other Images to a Distance", Patent No. 267,513.

<sup>263</sup> Ballard, "Television System", Patent No. 2,152,234.

<sup>264</sup> Sanabria, "Method and Means for Scanning", Patent No. 1,805,848, 2.



I propose to eliminate (sic) this objectionable interference caused by the side-bands by interposing dissimilar wave forms so that no particular wave form will be repeated a sufficient number of times to overcome the inertia of the circuit having selective frequency characteristics, therefore, a signal is not permitted to build up to sufficient strength to be a factor within the range of practical perceptibility.<sup>265</sup>

Sanabria's rather confused stated claims seem to focus on the reduction in interference that the technique would offer if the images were to be transmitted by wireless. Making the most of the very limited Nipkow disc resolution and minimising flicker were major advantages of Sanabria's system, but that may not have been fully appreciated at the time of the patent application.

Interlace was not the only important differentiating feature of Sanabria's system. Another idea, applied to the mechanism of the rotating Nipkow disc, was arguably as important as interlacing. The idea greatly improved the synchronisation (see Appendix 3.3) between the pick-up and the display Nipkow discs, and it depended simply upon the choice of electric motor used to drive them. Sanabria developed a much more simple method than that of his competitors and it was both accurate and cheap. His method depended on the spread of AC electrical supplies throughout the populated areas of North America and its inherent system of synchronised generators.<sup>266</sup> The chosen frequency of the AC mains in the Chicago area in the 1920s was 60 c/s and this was common in frequency and phase over a very wide geographic area. Sanabria's idea was to use synchronous motors to drive both ends of his television system. Such a motor, provided that the mechanical load is not too great, will turn at a rate dependent only upon the supply frequency, thus guaranteeing the speed condition. Phasing needs to be set only once, and this was carried out by manual intervention controlled by a knob on the receiving disc. This knob can be seen in the photograph of a later Western Television receiver, shown in Figure 3.5a and Figure 3.5b, in the form of a ship's wheel. By using this simple

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<sup>265</sup> Ibid., 1.

<sup>266</sup> Hughes, *Networks of Power*, 324-325. The 'power pools' or 'grids' formed by utility companies required their supplies to be commoned, resulting in frequency synchronisation.

approach Sanabria's system achieved stable synchronisation whatever the quality of the received signal, and 'losing sync' seems to be raised only very rarely as a criticism of Western Television's pictures, unlike competitors pictures.<sup>267</sup>

A closed circuit television system with the pick-up and display device in the same room was and easily demonstrated to potential backers and interested parties. To be truly useful and to fulfil the implied description of 'distant vision', it was necessary to either send the pictures by wire (telephone lines), or over the air (wireless). Other electro-mechanical television researchers, such as Gray at the Bell Telephone laboratories, were working towards a television system for use as a visual addition to the telephone, and proceeded with developments based on sending the signals over telephone wires. Sanabria chose to pursue developing television via wireless links as a mass market application, and also attempted to adapt it for cinema presentation. Sanabria's cinema demonstrations undoubtedly had massive novelty appeal, and in this he was working in parallel with the activities of the British Baird who was conducting similar experiments and demonstrations at about the same time. The pinnacle of the cinema demonstrations was probably the Broadway Theatre event in New York, on October 22nd 1931. This featured 'girls, comedians, dancers and movies' and one report of the event stated that the television act 'packed the house from noon to midnight'.<sup>268</sup> The system used the usual triple spiral Nipkow disc but with a high power neon 'crater' lamp which could provide sufficient light intensity for a screen of about 40 sq. ft.<sup>269</sup> As with Baird's demonstrations, it is highly unlikely that the image quality could have sustained long term viability beyond the novelty phase.

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<sup>267</sup> Kurtz, *Educational Television*, 116-120. Shows detailed reception reports of a station using Sanabria's system do mention occasional 'movement' of the image but at long range – possibly out of the synchronised public mains supply area.

<sup>268</sup> Hertzberg, "Television hits Broadway", 654-655.

<sup>269</sup> A 'crater lamp' was a high intensity point source neon lamp. An ordinary arc or incandescent lamp would not have been fast enough in its response to have followed the television video information, but a neon lamp, as used in most electro-mechanical receivers of the 1920s and early 1930s, was fast enough. The special 'crater' type combined the speed of the neon lamp with a relatively high light output concentrated in near point source suitable for projection optics. It could not, though, match contemporary cinema level brightness.

Sanabria could, conceivably, have licensed his system to telephone companies for point-to-point communication, but this was unlikely to be an option, as the large telephone companies had by their own efforts virtually all of the technology needed to make Nipkow disc based television work, at least within its fundamental limitations. Some Western Television resources were put into developing a 'picture phone', and some were sold, but the exact nature and records of this activity have not been found. However, a later Sanabria company of the mid 1930s, the American Television Institute, was certainly active in this field.<sup>270</sup> With the popularity of wireless growing daily, most of the electro-mechanical television companies and inventors in the United States took the 'wireless with pictures' path to further their technology and commercial prospects.

This meant not only sharing the broadcast bands with the existing wireless stations but with other television operators. Wireless stations were springing up all over the United States in the 1920s with little in the way of government regulation, other than by two small Federal departments: the Bureau of Navigation and the Radio Division of the Department of Commerce. As the wavebands descended into chaos in the mid-1920s, following the rapid growth in the number of wireless stations, the American government set up the Federal Radio Commission (FRC) by Act of Congress in 1927, to regulate the issue of wireless transmitting licences and to plan the use of radio spectrum space.<sup>271</sup>

Any company or organisation now wishing to transmit had to apply for a licence from the FRC, but the chaos continued for some time with competition for frequencies, radio power entitlement, broadcasting times and technical quality being rife. All television experiments had to fit in with this over-crowded and only semi-regulated system, but television had its own unique problems. It had been known for some years that the radio bandwidths needed by television systems offering even modest picture detail (resolution) were higher than those of speech transmissions.

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<sup>270</sup> McVoy, "American Television Institute".

<sup>271</sup> US Congress Act for the regulation of radio communications, and for other purposes H.R. 9971 69th Congress Acc. No. 632 Feb 23 1927.

Furthermore, experimental transmissions revealed another problem in that the sideband energy of an amplitude modulated (AM) radio frequency carrier contained considerably more high frequency content and at a higher amplitude leading to ‘splatter’<sup>272</sup> and thus causing interference to adjacent stations (see Figure 3.11). As wireless receiving sets of all types in the 1920s suffered from poor selectivity (the ability to tune to a wanted station whilst rejecting adjacent signals), the problem of interference was huge. Furthermore, the propagation characteristics of the medium-wave wireless broadcast band meant that the night-time range of transmitters was considerably more than the daytime range. Coupled to the ‘fading’ problems of this extended night-time range the interference generated was often intolerable, potentially threatening the popularity of the new medium. The American government exercised a fairly light touch on radio regulation, but it began to tighten its control in response to the congestion uses, but it was still much more liberal than the control of the airwaves in Britain under the direction of the General Post Office (GPO).

Licensing of wireless stations in the United States began in 1912 and by the 1920s a system of ‘call signs’ had evolved.<sup>273</sup> In the case of television, after the formation of the FRC, all such stations had to incorporate the letter ‘X’ in the call sign to indicate ‘experimental’. Such stations could not broadcast advertisements but this did not seem to prevent interest from potential television broadcasters, who would have assumed that a full commercial licence would eventually be granted. By the time that Sanabria began his work in Chicago in 1924, the city had several sound wireless broadcasting stations operated by a variety of operators from newspapers to private individuals. One of these stations was WCFL, operated by the Chicago Federation of Labor (CFL), as ‘the voice’ of organised union labour and they began broadcasting in July 1926 from a location on the lake front known as the ‘Navy Pier’.<sup>274</sup> By mid-1928, Sanabria and his associates were ready for their first television broadcast using

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<sup>272</sup> ‘Splatter’ was (and remains) a common wireless slang term to describe over-modulation and other effects resulting in a transmission occupying considerably more spectrum space than it should and causing gross interference to other stations as ‘adjacent channel modulation’. In Britain it was often termed ‘blasting’.

<sup>273</sup> White, “An Act to regulate radio communication”.

<sup>274</sup> “Radio Timeline”.

the WCFL radio facilities at the Navy Pier. Broadcasting on the medium-wave broadcast band on a frequency of 620 kc/s, E N Nockels, secretary of the Chicago Federation of Labor was televised head and shoulders on June 19<sup>th</sup> 1928.<sup>275</sup> It is unclear what the commercial relationship of Sanabria and the CFL was at that time and whether Hearst Newspapers was still backing him financially.

By the time of the demonstrations, Sanabria had appointed an engineer, Mel Hayes, to assist with design and development and the name of Hayes features in a newspaper report about the demonstration which notes the inventors as being ‘M J Hayes and Ulysses Znarbria (sic)’.<sup>276</sup> This report mentions accompanying sound, but that would have required an additional transmitter. The demonstration, conducted by transmitting from an existing sound wireless installation, is likely to have suffered from restricted bandwidth further limiting the picture quality, as Sanabria’s television standard required at least a 30 kc/s bandwidth for best results. A typical sound transmitter of that time would have had barely a third of this (see Figure 3.11). Unfortunately there is no reliable contemporary description of the technical quality of the WCFL demonstration. The only description is one written by Sanabria’s future employee, Parker, written by him in 1984. He noted that:

In Chicago that summer (1928) Sanabria was working with radio station WCFL, experimentally sending his television signals out over the broadcast channel. He invited me to witness the operation, located at the end of Navy Pier. The television images were quite good, having excellent half-tones and good definition.<sup>277</sup>

As Parker wrote this in 1984, the account might be questionable, and we do not know what he was comparing the pictures to. There has been speculation that WCFL actually used their experimental short-wave transmitter, call sign W9XAA, which

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<sup>275</sup> Sternberg, “Chicago Television”, 229.

<sup>276</sup> “Broadcast Scene and Sound”, *New York Times*, 1928.

<sup>277</sup> Parker, “Early Chicago Television”.

had a wider bandwidth and thus better suited to television work, but this is contrary to a comment by the chief engineer of WCFL in 1930.<sup>278</sup>

By 1928, Sanabria had gathered around him several capable engineers and assistants including Hayes, Parker and Garner, all three coming from university educated engineering backgrounds. Later that year, another name was linked with this group: that of Clement F Wade, a graduate businessman, who became president of a company set up to exploit Sanabria's inventions. Wade had founded a company called the Eskimo Pie Corporation in Chicago to make and market a chocolate-covered vanilla ice cream bar wrapped in foil.<sup>279</sup> Wade's new company, Western Television Corporation, was located in Louisville, a district of Chicago, set up in the premises of U.S. Foil Co., a company that made the aluminium foil wrappers for Eskimo Pies and was in turn owned by R S Reynolds of Reynolds Metal Co.<sup>280</sup> As an alternative to the broadcasting to the home model for television, Wade was interested in an idea to use television to broadcast stock market reports in competition to Western Union's 'ticker' system.<sup>281</sup> Following a demonstration of the proposed system to Reynolds in New York, Western Union put a stop to the operation.<sup>282</sup> A promising application for electro-mechanical television appears to have been eliminated at a stroke, although in Britain, Baird continued to work on something similar in the form of the 'telewriter', an idea which had applications in secure military communication.<sup>283</sup> With notions of alternatives to ticker tape gone, the technical and commercial emphasis of Western Television returned squarely to broadcast television in direct competition with others.

By 1928 there were less than half a dozen companies devoted solely to electro-mechanical television development in the United States., a similar number of the

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<sup>278</sup> Udelson, *Great Television Race*, 66.

<sup>279</sup> Parker, "Early Chicago Television".

<sup>280</sup> Ibid.

<sup>281</sup> 'Ticker' services based on an electro-mechanical paper tape printer connected to a telegraph line receiving the latest stock prices 'broadcast' over the lines by the United States stock market were a profitable side of the American telegraph company Western Union.

<sup>282</sup> Parker, "Early Chicago Television".

<sup>283</sup> Kamm and Baird, *John Logie Baird*, 134-135.

large corporations were also pursuing research. Of these, companies such as Hollis-Baird,<sup>284</sup> Jenkins, GE and RCA were all turning towards the idea of electro-mechanical television broadcasting, suggesting that the concept of broadcast television was gathering support. To investors, it would probably have seemed like there might be a market for this new technology and the dawn of a new industry, just as investment via the stock market in such new technologies and companies was reaching a peak. Western Television Corporation had the whole of Chicago and much of the state of Illinois as a potential marketing area. Given that the medium-wave broadcast band electro-mechanical transmissions had a large coverage area, with several hundred miles' range being quite possible, the potential audience was vast. Furthermore, all of the companies involved had systems using a different format, so a unique receiver type was required for each one, tying the purchaser in and arguably discouraging sales in the first place. The business of television had opportunities and Western Television had, limited as it still was, the best technical performance of any of the electro-mechanical systems. Under Wade's commercial direction the company embarked upon an ambitious path to make the new invention profitable.

### **3.3.2 Making television make money**

There are two possible ways for a broadcast television system to make money – making receiving equipment in quantity for the domestic market, or selling air-time to advertisers and sponsors. The latter avenue was still closed to all companies, large or small, because television advertising and sponsorships were still forbidden by the FRC. The only way to make any money in the short-term was to establish a basic transmission system and make receivers for sale, hoping that the operation would gain in popularity and gather momentum, eventually hoping to lose the 'experimental' designation. To this end, Wade secured some investment from financial services company, Nelson Brothers Bond and Mortgage Company. They were already involved in sound broadcasting, owning Chicago station WIBO (run as

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<sup>284</sup> Hollis Baird founded the Shortwave and Television Corporation in Boston in the United States. He had no personal relationship to Britain's John Logie Baird.

a side-line to their main business), and the prospect of adding television to their output appears to have been attractive.<sup>285</sup>

In late 1928 the FRC changed the existing very lax rules for television broadcasting as interference from experimental television stations was becoming a serious problem to sound only broadcasters. The bandwidths required for a television system that could offer anything like a viable picture resolution – even using Sanabria's interlacing technique – were not compatible with medium wave broadcasting and its necessarily narrow channel allocations, even with the relatively small number of stations on air.<sup>286</sup> The FRC concluded that the only solution was the migration of television to higher frequency bands which would also provide for wider channels. They gave a short period of grace for existing stations to move, but from the publication of the Order in November 1928 until January 1929 the transitional rules were firm:

Between the date of this order and January 1, 1929, picture broadcasting and television broadcasting will be permitted to a limited extent (but only upon written application to, and formal authority from, the commission) in the broadcast band between 550 and 1,500 kilocycles, subject, however, to rigid conditions designed to prevent interference with the reception from broadcasting stations. Among such conditions will be the following: (1) That the band of frequencies occupied by any such transmission shall not be wider than 10 kilocycles, and (2) that such picture broadcasting and television broadcasting be limited to periods of not more than one hour per day at a time of the day other than between 6 and 11 pm.<sup>287</sup>

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<sup>285</sup> Federal Radio Commission v. Nelson Bros. Bond & Mortgage Co. (station WIBO). Same v. North Shore Church (station WPCC). Federal Radio Commission et al. (station WJKS) v. Nelson Bros. Bond & Mortgage Co. (station WIBO). Same v. North Shore Church (station WPCC), 1933 See: <http://altlaw.org/v1/cases/396760> Accessed 05/15/2009.

<sup>286</sup> Medium wave broadcasting in the United States in the 1920s meant 550 kc/s to 1,500 kc/s.

<sup>287</sup> Department of Commerce, Radio Service Bulletin, Nov 1930, No. 140, US Government, 16.



At first sight this sign of increased government regulation might look like a burden to the new companies trying to establish television. Prior to these changes, potential viewers of the new services had only to buy (or build, as was popular at the time) a suitable display device and connect it up to an existing wireless set. A second, special, wireless set would now be needed along with a standard set if there was accompanying sound. This added more cost, but a cost that might be considered worthwhile to a potential purchaser as the dedicated band offered wider channels and hence potentially much increased picture quality. Eventually, over a year after the initial restrictions, on December 22<sup>nd</sup> 1928 and after much deliberation by the FRC, the new ‘television band’ was released covering 2,000 to 2,300 kc/s and from 2,750 to 2,950 kc/s with channel bandwidths set at 100 kc/s.<sup>288</sup> The core reasoning behind these decisions about assignments and the channel width had been made after receiving submissions from RCA, but no single person or organisation fully understood the requirements of television broadcasting at that time. The understanding of the relationship between picture quality and radio bandwidth was evolving, but developments such as Sanabria’s interlace system confounded contemporary predictions. The technical understanding regarding the bandwidth needed for visual transmissions remained hazy, but the FRC had to make a quick judgement to deal with the spectrum demands of the rapidly developing technology.<sup>289</sup> The restriction on banning advertising and sponsorship of these ‘experimental’ broadcasts was to continue and the licences would run for one year at a time, with the operators required to produce an annual report.<sup>290</sup> The regulatory ground rules were now in place and Western Television could, along with the other companies in competition with them, start to build broadcasting stations and manufacture receiving sets for the general public with some belief in the future stability and continuity of the political governance of the radio spectrum for television.

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<sup>288</sup> Stern, “Regulatory Influences”, 354.

<sup>289</sup> Ibid., 352.

<sup>290</sup> Federal Radio Commission Order #50, Television and Picture Transmission, Nov 30, 1928, 16-17

As a result of these changes, a new class of wireless receiver had to be developed from existing sound broadcast band designs. Lacking the manufacturing capacity and the expertise to do this, Western Television purchased a small Chicago based wireless manufacturing company known as Echophone Inc. to facilitate receiver production. The display part of the receiver, the Nipkow disc and neon lamp, was also to be made by Echophone, and was called the 'Visionette' (shown in Figure 3.5). Going on sale towards the end of 1929, the Visionette had a 17-inch Nipkow disc and sold as a kit for \$88.25 without the special neon lamp (called the 'Kinolamp') and the cabinet was an extra \$20.<sup>291</sup> The special receiver cost \$85 ready-made and a console to fit everything in was another \$20. In addition, another conventional wireless set was needed to pick up the sound.<sup>292</sup> This was expensive, but set against the price for a good sound-only wireless in a good cabinet which would have been around \$100, it would have been a reasonable price for a moderately wealthy potential purchaser.

Western Television began designing and installing their studio and transmission equipment in early 1929. Their first regularly operating television studio and transmitter was engineered by Sanabria and his team, adopting the already tested format of 45 lines, 3:1 interlace at 15 frames per second. Unlike Baird's system, with its 'portrait' format of 30 vertical lines and 12.5 frames per second, Sanabria's system had a 'landscape' format and horizontal lines. The television station's call sign was W9XAO, and together with the existing sound station, WIBO, offered regular simultaneous sound and vision programming with daily listings in the *Chicago Daily News*. The owners of this independently owned newspaper (not connected with Hearst Newspapers, Sanabria's original investor) received their own licence from the FRC to transmit television. The company was already operating a sound wireless station, call sign WMAQ, from its prestigious headquarters in Chicago, and the new television station would operate alongside it. Again, designed and built by Sanabria's team, the new station, having television call sign W9XAP,

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<sup>291</sup> The 17-inch Nipkow disc was not the picture size – this was still only about 2 by 1.5 inches and viewed through a lens.

<sup>292</sup> Yanzcer, "Ulises Armand Sanabria".

used WMAQ as its sound channel and opened on August 27<sup>th</sup> 1930.<sup>293</sup> Programmes were constrained by the limitations of the flying spot pick-up method, but they were regular and ambitious featuring plays, boxing, recitals, cartoons and variety. Throughout 1930 and 1931, the station continued to grow adding multi pick-up productions to enable more complex productions such as plays. With the high power of their television transmitter (2,500W) reception was possible over several hundred miles, with reception in up to seventeen states.<sup>294</sup>

Between 1929 and 1933, Western Television constructed several more television stations and many more were proposed, including some in Canada. The seven stations actually built and working appear in Table 3.1. One such contract-build station, W9XK, was unusual in being a university television station attached to the State University of Iowa and first licensed in September 1931.<sup>295</sup> The coverage of this station was impressive, covering most of the state of Iowa and beyond. It was a pioneering station in that it attempted, with some success, to use television for educational purposes.<sup>296</sup> Sample pictures from W9XK, some of the only known off-screen images from a Sanabria engineered system, are shown in Figures 3.8 and 3.9. It was not unique in being a university-based television station, but compared to others it was certainly successful in attracting viewers well beyond the university campus, from all over the state of Iowa and beyond. Reports of picture quality and of programme content varied tremendously, often depending on atmospheric conditions and interference from other television stations, but most accounts were favourable when conditions allowed.<sup>297</sup>

Western Television continued to develop its domestic receivers, incorporating as many technical advances as possible that could yield larger and brighter pictures, but no attempt was made to improve the scanning standard. How many sets were sold is not known, as the company's records do not survive, but it is unlikely that more than

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<sup>293</sup> Sternberg, "Chicago Television", 229-252 and 230.

<sup>294</sup> "Western Cities Report Getting W9XAP Clearly", *Chicago Daily News*, 1931.

<sup>295</sup> Kurtz, *Educational Television*, 12.

<sup>296</sup> *Ibid.*, 73-76.

<sup>297</sup> *Ibid.*, 116-140. Shows detailed reception reports.

a few thousand were ever sold. Western Television Corp. was dissolved in 1935, though Sanabria himself was able to start a new television company based on teaching television technology, the American Television Institute. Sanabria and Western Television Corp. represent the new company approach to commercialising electro-mechanical television, competing not just with other small companies, but with larger, well established concerns. At the core of all Western Television's developments was the Nipkow disc, with all of its difficulties. Such opto-mechanical issues were shared by all companies, large and small, who were trying to make such television work – as I explored for myself in Appendix 3.5. I will now turn to an example of a large company trying to make electro-mechanical television a viable proposition in the early 1930s, the major British concern, MWTCO.

### ***3.4 The large company approach to electro-mechanical television: Marconi's Wireless Telegraph Company Ltd.***

Most of the large wireless and telephone companies based in the United States, Britain, France, The Netherlands, Italy and Germany attempted, with varying degrees of commitment and success, to make broadcast television a reality using electro-mechanical technology in the early 1930s. Given the much freer radio regulatory system in the United States compared to the major European countries, it is not surprising that there were not so many attempts in Europe to launch commercial television transmitting stations following the model of the Western Television Corp. This inability to licence a broadcast station was a challenge that John Logie Baird, and his initial start-up company Baird Television Ltd., continually railed against, having to rely on the goodwill of the BBC and the British radio regulatory body in the form of the General Post Office (GPO).<sup>298</sup> It was also unclear how any company could make money out of television other than by selling receivers if, as was the case in Britain, on-air advertising was prohibited.

Marconi's Wireless Telegraph Company Ltd. (MWTCO.), as of 1929, was one of the largest and most powerful wireless companies in the world, controlling large sections of international marine communications, inter-continental wireless traffic, equipment

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<sup>298</sup> Briggs, *The BBC*, 156-157.

manufacturing operations and having key patent holdings. One area of the wireless industry that MWTCO. was no longer concerned with was that of consumer manufacturing of domestic receivers, having sold all of its interests to another British organisation, the Gramophone Company Ltd., along with the right to use the trademark “Marconiphone” and the copyright signature “G. Marconi”.<sup>299</sup> In most respects, the disposal of the domestic receiver business made sense, as the company was primarily a capital goods manufacturer and a wireless service operator. The company’s very expensive transmitters and ancillary equipment were made under model shop conditions which did not fit well with the mass production of domestic wireless sets, so the disposal of that side of the business was not viewed with regret. As a consequence of the disposal, MWTCO.’s interest in television, whatever it might ultimately be for, was not going to be in the mass production of receiving equipment. The company had agreed, as part of the sale of their domestic receiver business, not to pursue any consumer manufacturing activities for a period of 20 years, beginning in 1929.<sup>300</sup>

### **3.4.1 Review of MWTCO.’s television options**

MWTCO.’s famous founder, Guglielmo Marconi, is sometimes quoted as not being interested in the idea of television, either personally or on behalf of his company.<sup>301</sup> There is some evidence to the contrary as a well-illustrated whole page article, carrying Marconi’s name as author, appeared in *The Times* in 1931 apparently showing great interest in the possibilities of television. Whether these were his own words and whether he personally shared the sentiments is unknown, but the tone is certainly upbeat, stating:

Transatlantic and Imperial wireless telephony and the transmission of pictures by wireless are among the latest contributions by research engineers to the facilities for communication which the business world now possesses; and should the intensive work on television now in progress in our laboratories give us, as we hope it will at no distant date, the results for which

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<sup>299</sup> Baker, *A History of the Marconi Company*, 199-200.

<sup>300</sup> Ibid., 200.

<sup>301</sup> Jolly, *Marconi*, 265.

we are striving, the public will again be afforded an opportunity of assisting in the development of a new art and industry, that of visual broadcasting.<sup>302</sup>

The reference appears to be towards developing the broadcasting model for television – adding pictures to the existing wireless – but that does not appear to be what his company’s directors and management had in their minds. A television research group was formed by the company in August 1930, with terms of reference directing it to concentrate on receivers, transmitters, modulation systems and antennas.<sup>303</sup> Although research into pick-up devices appears to have been beyond its remit, cathode ray tube (CRT) scanning for domestic receivers was included, despite the recent loss of MWTCO.’s domestic wireless set business. This was presumably included as a possible patent creating exercise whilst at the same time creating useful technology for non-consumer receiver applications.

MWTCO.’s decision to go into the business of television research in 1930 was taken only after some very careful investigations. As one of the leading wireless companies of the time, MWTCO. had many information gathering resources at its disposal including international subsidiaries, representatives and contacts. Through its historical links with RCA, MWTCO. had full access and rights to that company’s patents and technical developments.<sup>304</sup> Gathering information about the contemporary state of television development involved MWTCO. in asking for reports from several of its consultants. In Hungary, Dr Sergei M Aisenstein, an exiled Russian engineer, reported on the work of Hungarian inventor, Mihály, and on the television developments made by German wireless giant, Telefunken.<sup>305</sup> In Britain the Television Society president, John Ambrose Fleming, was approached by MWTCO. to write a full report about existing television developments and the longer-term prospects. As well as being a highly respected engineer-scientist, Fleming was also a supporter, personal friend and confidante of Baird, who would

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<sup>302</sup> Marconi, “Development of Wireless Communication”, *The Times*, 1931.

<sup>303</sup> Baker, *A History of the Marconi Company*, 260.

<sup>304</sup> Sidak, *Foreign investment in American telecommunications*, 47-48.

<sup>305</sup> Burns, *British Television*, 195-197.

have known intricate details of his work and plans.<sup>306</sup> Aisenstein's report appears to have been very favourable towards the work of Mihály, but Fleming's analysis submitted in February 1930 was not particularly enthusiastic about any aspect of television. He did suggest that high-speed message scanning, especially of non-Roman script such as Chinese could be practical and useful.<sup>307</sup> On the prospects for televising real, moving scenes and people, Fleming suggested that good results over long distances might be possible using the short wave beam system.<sup>308</sup> He felt that he could not recommend that MWTCO. acquire rights or control in any television company but he did suggest that the company should keep a careful watch on developments.<sup>309</sup>

Following the report phase, it took some time for MWTCO. to set up its television research department, taking until August 1930. Its terms of reference seem to have been fairly closely allied to Fleming's largely pessimistic analysis and recommendations. Neither Mihály nor Baird would be involved in MWTCO.'s research, the company preferring to use its own skills and resources. Despite not having any 'expert' on hand they were soon able to produce versions of known electro-mechanical television pick-up and display devices and couple them to their well-established transmitter and receiver technology. MWTCO. was well placed to create such versions of the known apparatus such as Nipkow discs and drum scanners, as its precision mechanical fabrication facilities under model-shop conditions were highly developed.

Once finally committed to television, MWTCO. wasted no time in creating working prototypes and carrying out demonstrations to rival those of Baird. The first publically reported demonstration was in July 1932, with an ambitious transmission of a 50 line head and shoulders portrait at a frame rate of 12.5 frames per second from Chelmsford in Britain to MWTCO.'s associate company in Australia,

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<sup>306</sup> Kamm and Baird, *John Logie Baird*, 158.

<sup>307</sup> Burns, *British Television*, 194-195.

<sup>308</sup> The short wave beam system was MWTCO.'s method for long range communication developed in the 1920s bouncing short wave radio signals off the ionosphere in single and multiple hops.

<sup>309</sup> Burns, *British Television*, 195.

Amalgamated Wireless (Australasia) Ltd. (AMA). The transmission took place on the 25 metre short-wave band and was thus subject to the usual signal fading and phase distortions, leading to an unsatisfactory image and poor synchronisation.<sup>310</sup> An associated test, of a 'news system' (text) on a travelling tape of 10 lines at a repetition rate of 12.5 frames per second was more successful. As Baird had transmitted a very poor 30 line television picture across the Atlantic in 1928, this appears to have been an attempt to out-do and out-headline Baird.<sup>311</sup> Figure 3.9 shows the transmitting end pick-up system which from its appearance suggests a Nipkow disc scanner of the flying spot type having a photocell picking up the reflected scanned light beams.

H M Dowsett, appointed as Research Manager for MWTCO. in November 1931, described the company's position with regard to television in a July 1932 article relating to the transmissions to Australia, thus:

As it is the business of the Marconi Company to consider the various applications of wireless in the widest sense, its development of television has not been limited to the amusement field, and its research engineers have therefore been able to approach the problem from a different angle from that of broadcasting pictures.<sup>312</sup>

This is a significant confirmation of the direction in which MWTCO.'s directors were taking the company with regard to television development in moving towards non-broadcast, specialist applications. Dowsett's almost mocking expression of 'amusement field', when referring to broadcast television probably reveals the company's opinion of Baird's work and the experimental BBC transmissions of the period as being nothing more than a curiosity.

The first full public demonstration of MWTCO.'s television news system was carried out shortly after the Australian experiment in September 1932, but over a much more modest path length between Chelmsford and St Peter's School in York, as the city

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<sup>310</sup> Baker, *A History of the Marconi Company*, 261.

<sup>311</sup> Moseley, *John Baird*, 82.

<sup>312</sup> "News by Television. A Marconi Development", *Television*.



hosted a British Association meeting. Again, two demonstrations were shown. One was the ‘news system’, with a picture transmitted from Chelmsford composed of only 15 lines, but at 20 frames per second leading to much smoother motion of the moving messages. This modest demonstration, even by the standards of the time, appears to have been well received by the national press.<sup>313</sup> The second demonstration was transmitted from York to Chelmsford and comprised a 50 line picture with a frame rate of 15 pictures per second. The image was of a live subject, both head and shoulders and full-length being displayed on an eight inches square ground glass screen.<sup>314</sup> Why the transmission direction was reversed for this test is not known. Other demonstrations followed both in public and in private but the last major demonstration of MWTCO.’s electro-mechanical television prowess was to another British Association meeting in September 1933 in Leicester. Again, at 50 lines and 15 frames per second, the displayed image was sent over a short range modulated light beam link to a television projector displaying its image on a 5ft square screen.<sup>315</sup>

Back at the Chelmsford laboratories, the television system line count was pushed up to 100 lines and beyond. MWTCO. possessed wide-bandwidth transmitters capable of transmitting signals occupying 250 kc/s and operating on the ultra-short wave band of 6.8 metres wavelength. Such transmitters had been developed in 1932 and the company continued to pursue the techniques necessary for still higher bandwidths. Whilst MWTCO. had achieved respectable results with their electro-mechanical pick-ups and displays, there was still no credible application that could be profitable to warrant further investment. Transmitter development was one of the company’s principal strengths, with industry-leading technology, but with regard to television pick-ups and displays they were industry followers, only able to keep up by virtue of their prototype building skills and wide resources across the company.

In 1933, with news coming from across the Atlantic of radical new developments in all-electronic techniques and the commercial collapse of some of the dedicated

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<sup>313</sup> “Marconi secret out”, *News Chronicle*, 1932.

<sup>314</sup> Baker, *A History of the Marconi Company*, 262.

<sup>315</sup> *Ibid.*, 262.

electro-mechanical television companies around the world, MWTCO.'s directors were faced with hard decisions about continuing on with the technology themselves or linking with another company. There accounts of stories of a potential merger of television interests with Baird Television Ltd., but there is no evidence to support such plans in MWTCO.'s records.<sup>316</sup> A merger of MWTCO.'s television interests did eventually take place, though it was not with Baird's company but with the relatively new company of Electrical and Musical Industries Ltd. (EMI) in April 1934. EMI shared some common commercial history with MWTCO. via RCA, and amalgamating their television interests to form Marconi-EMI Ltd. enabled them to jointly develop all-electronic television using key ideas from RCA in the United States. This marked the end of MWTCO.'s brief interest in electro-mechanical television. The subsequent narrative of Marconi-EMI Ltd. is covered in Chapters 5 and 6.

### ***3.5 Excellence in electro-mechanical television by Scophony Ltd.***

Of all the electro-mechanical television techniques invented and developed by the mid-1930s, the technology known as Scophony had no rival in terms of technical performance. No complete equipment survives but some of the core technology is still in use today – in contrast to all of the other methods employed by electro-mechanical systems, which have very few or no uses. The technology itself takes its name from the name of the company founded in Britain in 1930 as Scophony Ltd. to develop it. There is no evidence about the origins of the strange name but the 'Sco' part is probably a contracted form of 'scope' (a viewer, from the Greek) and the 'phony' part from 'phono' relating to sound (also from the Greek). The description thus becomes 'sound viewer', yielding a fairly close idea about how the invention works. It worked by using a method based upon the diffraction of light in a grating producing interference patterns to modulate the intensity of a beam of light. The machine consisted of a two part scanner, the 'low speed' and the 'high speed'. Each part of the scanning system was considered as a separate function and the two were optically combined by a patented method known as 'split-focus'. The low speed

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<sup>316</sup> Moseley, *John Baird*, 71 and 214-215; Kamm and Baird, *John Logie Baird*, 257.

scanning was accomplished by the well-established early 1930s technique of a rotating mirror drum, whereas the high speed scanning was based on a combination of a patented acoustically modulated diffraction grating and a very fast drum scanner. A fuller technical description of the complete Scophony technique is presented in Appendix 3.3.

The formation of Scophony Ltd. was the culmination of much commercial activity in Germany in the late 1920s. It was derived from another company originally set up to develop the ideas of Mihály and other Hungarian expatriate engineers working there. The leading figure in Scophony Ltd. was a Zionist Russian, Solomon Sagall, who had fled Soviet Russia at the age of 22 in 1922. Reaching Berlin, he studied economics and political science at the University of Jena but did not graduate, leaving there in 1925 to study at the London School of Economics, where he again failed to graduate. His primary interest was Zionist journalism, but to make money his attention turned to business and in the late 1920s he attempted, unsuccessfully, to sell made-to-measure suits manufactured in Leeds for customers in Berlin. Undeterred by business failure, an article in the *Observer* newspaper in May 1929 provided the impetus for his next venture.<sup>317</sup> The article reported on the Telehor television work of Mihály in Berlin, and Sagall opened negotiations concerning the setting up of a British company to exploit the system in Britain. This company, registered in 1930 as the British Telehor Company Ltd., was headed by Sagall, who, as an experienced journalist, managed to secure favourable press coverage for the launch.<sup>318</sup> As a direct result of this publicity he was approached by a British inventor from Lancaster called George William Walton who claimed to have invented a novel mechanical method for television. Not being an engineer, Sagall referred the device descriptions to two Telehor GmbH engineers, Gustave Von Wikkenhauser and Ferenc Von Okoliczanyi, both fellow Hungarians recruited by Mihály. Walton was invited to Germany to have his proposals examined further. He stayed for many months, culminating in the formation of a new company, Scophony GmbH, backed by Sagall and the principal Telehor GmbH investor, German financier Paul

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<sup>317</sup> "Television and Education", *The Observer*, 1929.

<sup>318</sup> Singleton, *Story of Scophony*, 15.

Kressman. Mihály and the Telehor system were not involved in the new company and it was to be a completely separate operation.

Kressman died early in 1931, leaving Sagall with only the shell company of Scophony GmbH (a British registered entity in the form of Scophony Ltd.), many debts, and Walton's ideas for large screen projection television. Seeking new finance Sagall approached leading cinema companies in Britain eventually finding support from Oscar Deutsch, the founder of the Odeon cinema chain. A full move to Britain resulted in Scophony Ltd. becoming established in a small office suite in Dean Street in Soho, the centre of London's film business. Wikkenhauser moved to London and the technical team was strengthened with other engineers joining including the optical designer John Henry Jeffree. By late 1932 the company consisted of six British people and one German national (this is presumed to be Wikkenhauser).<sup>319</sup> Under Sagall's management, Scophony now possessed finance, being capitalised to the value of £15,000.<sup>320</sup> It had unique patented techniques, potential customers in the form of the cinema companies and a team of able engineers. The company's task, as of the beginning of 1933, was to develop Walton's ideas as fast as possible to create a viable cinema television projector.

Whilst the very limited picture fidelity of the electro-mechanical television systems of 1933 really was not enough to compete with the highly successful cinema images, it was enough, as Sanabria, Baird and others had found, for great novelty interest and publicity. Baird had given two well-received demonstrations of televising the British Derby at the London Metropole Cinema, first with his established 30 line television standard in 1931 and then in the following year using his triple 'zone' system of three 30 line units operating side by side, giving 90 lines.<sup>321</sup> The first demonstration was barely recognisable as a horse race but the second showed considerable progress and met with great acclaim.<sup>322</sup> The public's response was huge, with 4,000 people attending the second demonstration, suggesting to backers that televising live events

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<sup>319</sup> Ibid., 22.

<sup>320</sup> Ibid., 20.

<sup>321</sup> Davis, "Derby finish".

<sup>322</sup> Kamm and Baird, *John Logie Baird*, 218.

to the cinema had a future. Baird had a complete television system and could stage such publicity seeking events. Scophony had no live pick-up technology of its own or transmission capabilities, so it would be dependent upon other companies and organisations to complete the system of cinema television. This is not to suggest that Sagall wasn't interested in pick-up and transmission. Walton had taken a patent out on a novel but optically very complex pick-up technology commonly known as the Stixograph, published in 1933.<sup>323</sup> It was fundamentally not sensitive enough to be used for live pick-up but could be used as a film scanner, where light intensity is not a problem. The Stixograph could produce high resolution television pictures using electro-mechanical technology, but using methods very different to the spinning discs and drums of Baird, Gray, Hollis-Baird and many others. On the radio and line transmission side, Walton made bold claims about being able to produce high-resolution television pictures within a bandwidth no wider than that needed for sound. The claims were viewed with great scepticism by the British Television Advisory Committee, set up to investigate the future of television in 1935. Aside from these audacious claims, the Stixograph produced good pictures from film, but the company's primary aim remained large-screen television projection.

In the Scophony projector, the two scanners, the high and low speed, were based on existing mirror drum technology, except that given the specification for high-resolution, the high-speed scanner had to work with motors running at rates of around 40,000 rpm, demanding extremely high precision and quality. The 'split focus' method, Walton's idea, which separated the optical focus of the high and low speed scanners and was based upon cylindrical lenses and only used conventional optical parts. The main differentiator in terms of technology which made the Scophony projector unique was the opto-acoustic light modulator. This enabled the projector to deliver an image some 1,000 times brighter than an equivalent Nipkow disc-based system.<sup>324</sup> The modulator was invented by the Scophony optical designer Jeffree, originally hired by the company to assist Walton in developing the Stixograph. The Jeffree modulator consisted of a container of liquid, typically

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<sup>323</sup> Walton, "Improvements in methods of and means for transmission by electro magnetic waves of television signals and the like", Patent No. 403395.

<sup>324</sup> Singleton, *Story of Scophony*, 54.

heptane or benzene, which had a piezoelectric transducer secured to one side. The transducer was driven by the incoming picture information modulated onto a radio frequency carrier. The high frequency picture information modulated the density of the benzene as a super-sonic audio signal. The alternate rarefactions and compressions in the liquid medium produced interference patterns in an incident light beam on the modulator which, when concentrated at an optical stop, modulated the instantaneous intensity of the light beam. The modulation was continuous owing to the relatively slow propagation of the supersonic signal through the benzene. The modulator actually 'stored' one whole television line at a time to be scanned by the high speed scanner resulting in large light efficiency gain over conventional scanners. As complex in principle as it was, the Scophony projector worked well with a prototype delivering 120 line pictures by the summer of 1934. A contemporary description of the pictures produced states:

The size of the picture was approximately 14 inches by 18 inches and the shape therefore was practically that of the cinema picture. Viewed from a distance of 12 feet every movement was clearly discernible and the entire action of the film could be followed easily.<sup>325</sup>

All-electronic television was by this date being shown with ever increasing line rates, and electro-mechanical television was generally finding it very hard to compete. Against this, Scophony Ltd. was able to continue with its development work, and the funding was actually increased with the addition of another investor, the large British consumer wireless manufacturer, Ekco Ltd., of Southend. The new Scophony Ltd. was registered in April 1935 having a share capital of £140,000, enabling a move to much larger premises in Thornwood Lodge, Campden Hill in London.<sup>326</sup> This new investment altered the course of development slightly in that the company research and development was spread over three products: a home receiver of 24 inches, a large screen system of 5 to 20 feet, and a film transmitter (telecine) using the split focus method. The domestic receiver needed to be able to work with the then proposed British all-electronic television standards of 240 and

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<sup>325</sup> "Scophony Projected Picture", *Television*.

<sup>326</sup> Singleton, *Story of Scophony*, 75.

405 lines (as addressed in Chapters 5 and 6) which required faster high speed scanning motors and better electronics. This goal was achieved by 1936 and Scophony was able to demonstrate both the home receiver and the large screen cinema projector. Following the success of the BBC television service which began in November 1936, the company had a real commercial reason to develop lower cost versions of its projection television sets. With Ekco Ltd. as their manufacturing facility, the prospects appeared to be bright, except for the price of the sets which was in the region of 220 guineas, or over twice as much as CRT-based sets (see Figure 3.11). It is unlikely that any were ever sold but they were exhibited at the primary wireless industry exhibition, RadioOlympia, from 1936 to 1939, as working units.

The large-screen cinema projectors had much more commercial success with a series of demonstrations and then permanent installations at cinemas in London, including the prestigious Odeon in Leicester Square. Plans were laid to equip dozens of the cinema News Theatres with television equipment, but Scophony had a rival in this plan: Baird Television Ltd. (BTL). Baird's company, now having little use for the man himself, had long abandoned electro-mechanical television and had developed a CRT-based cinema projector. The two techniques came to a trial when the BBC televised the Boon-Danahar boxing match of February 1939. Baird's installed their system at the Marble Arch Pavilion cinema under the auspices of the Gaumont-British film chain, whereas Scophony installed their equipment at the Monseigneur News Theatre, also in Marble Arch, owned by Tatler News Theatres. Both of the presentations had capacity paying audiences (this was not just a publicity stunt) and both systems worked well. Press reaction was very favourable for both systems, but the Scophony display was brighter, sharper and larger than the Baird company CRT apparatus. Scophony's success was repeated in March the same year with the Harvey-Gains boxing fight and the arrival in Britain of French President Albert Lebrun.

These encouraging commercial trials resulted in the installation of a very large-screen system at the Odeon, Leicester Square, which carried the Derby and the

Armstrong-Roderick world welter-weight boxing fight on a 15x12 feet screen.<sup>327</sup> Following critical acclaim from the press, the Odeon chain's Managing Director, Deutsch, announced that all 60 of the London Odeon cinemas would be equipped with Scophony projection apparatus.<sup>328</sup> This never happened due to the declaration of war in September 1939. With the BBC television service having closed down, Scophony's only short-term option was the market in the United States. This approach needed technical revisions to work with the new television standard there of 441 lines at 60 fields per second, interlaced. There was insufficient time to adapt both commercially and technically before the United States was also on a war footing. Scophony's skills were redirected to the war effort and the Scophony projection system never reappeared, despite its technical success and commercial promise.

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<sup>327</sup> Sieger, "Design and Development of Television Receivers", 492.

<sup>328</sup> Singleton, *Story of Scophony*, 192.



### **3.6 Conclusions**

The arrival of new wireless technology, in the form of thermionic valve-based amplifiers in the 1920s, eased many of the technical issues associated with the realisation of electro-mechanical television based on the late nineteenth century scanning principles of Nipkow, Weiller and Szczepanik. Electro-mechanical television was a limited technical reality by the late 1920s in both the United States and in Europe, but alongside the initial technical successes the main commercial issue was also being addressed: the need to find a commercially viable application, especially if the technology was only going to be able to deliver extremely crude images compared to contemporary cinema pictures. By the late 1920s potential uses had settled out into three main areas - broadcasting, direct communication and military applications. The broadcast applications centred on adding pictures to wireless broadcasting and/or 'live' pictures to the cinema's capabilities. Direct point to point communications, that is a signal intended for single individual reception, suggests applications of adding pictures to telephony (telephones with pictures) and high speed document transmission. Military ideas for television revolved around infra-red television for 'seeing in the dark' and in fog using infra-red rays, plus remote observation of guarded areas and possibly aerial surveillance by using systems transmitting from aircraft. None of these military aspirations became strong influences on the early development of television, due principally to the hopelessly poor image quality.

This chapter has mainly examined the broadcasting aspirations and some of the direct communication applications through the prism of three companies working to commercialise the technology. The narratives surrounding two of these three companies, Western Television Inc. and MWTC., suggest that the technical limitations of the electro-mechanical techniques would have affected all of the applications and all of the companies in much the same way. The very limited picture resolution, the complexities (and hence cost) of both receiving and transmitting devices, image flicker and difficulties in use, all contributed to the very limited take-up and adoption of television for any potential application. Apart from Scophony, all of the proponents of electro-mechanical television, whether as individuals or companies, were working with a relatively narrow set of ideas based

solely on Nipkow's disc, Weiller's drum or Szczepanik's mirrors. Western Television Inc., dedicated solely to electro-mechanical television development and the huge MWTCO., developing the technology as one of many in its diverse operations, represent two very different organisational approaches. Their technical goals and commercial aims also differed greatly but neither company could make much headway in turning the technology into a commercially viable business. It is highly likely that all of the potential applications of television were considered by both companies and there is some evidence to support that view, especially in the case of MWTCO. These two companies, along with the many other organisations in Britain, the United States, Germany, the Soviet Union, France and Japan, all worked on electro-mechanical television throughout the 1920s and the very early 1930s: they appear to have reached the same conclusion about its prospects at roughly the same time – sometime late in 1934 or early 1935 – that it had no commercial future. Certainly, MWTCO. and Western Television conform to that date range and this applies to virtually all of the other television companies and organisations of the period.

The case of the third company which I have described, Scophony Ltd., contradicts the idea that electro-mechanical television was unable to offer high resolution pictures with low flicker and thus useful image quality. What sets Scophony apart from all of the other companies pursuing the electro-mechanical route to television is radical and novel technology. Scophony's scientists and engineers did not doggedly follow the well-known and accepted methods – their techniques were radically different yet still essentially electro-mechanical. The Jeffree opto-acoustic modulator and the split focus system, could deliver high quality displays, capable of quality cinema presentation well beyond the novelty value. Whilst it is true that live electro-mechanical pick-up remained a challenge to all companies, the electro-mechanical scanning of film presented no serious problems yielding high quality results. Whether a successful electro-mechanical live pick-up could ever have been developed remains doubtful, but the Scophony technology for display was successful, if short-lived due to the outbreak of World War II.

Whilst work on specialist electro-mechanical television continued past 1934, there does appear to have been a very sharp drop in confidence and investment, as the new

technology of the all-electronic approach was revealed. This is described in the next chapter. Did electro-mechanical television really ‘fail’? If there had been no ‘new’ technology, of the kind I will describe in Chapter 4, I suggest that electro-mechanical television could still have eventually found a few applications, certainly in the cinema and probably in the home, but not in the form of the low-resolution versions as championed by Baird, Sanabria et al. Electro-mechanical schemes could have been improved to a satisfactory standard, given investment and time, but a useful television system, of any kind, would have been much harder to develop using such an approach. The case of Scophony confirms this view. An electro-mechanical television system based on Scophony’s technologies could have been achieved with two distinct forms; one based on large screen cinema applications and the second on a model based upon delivering cinema films to the home.

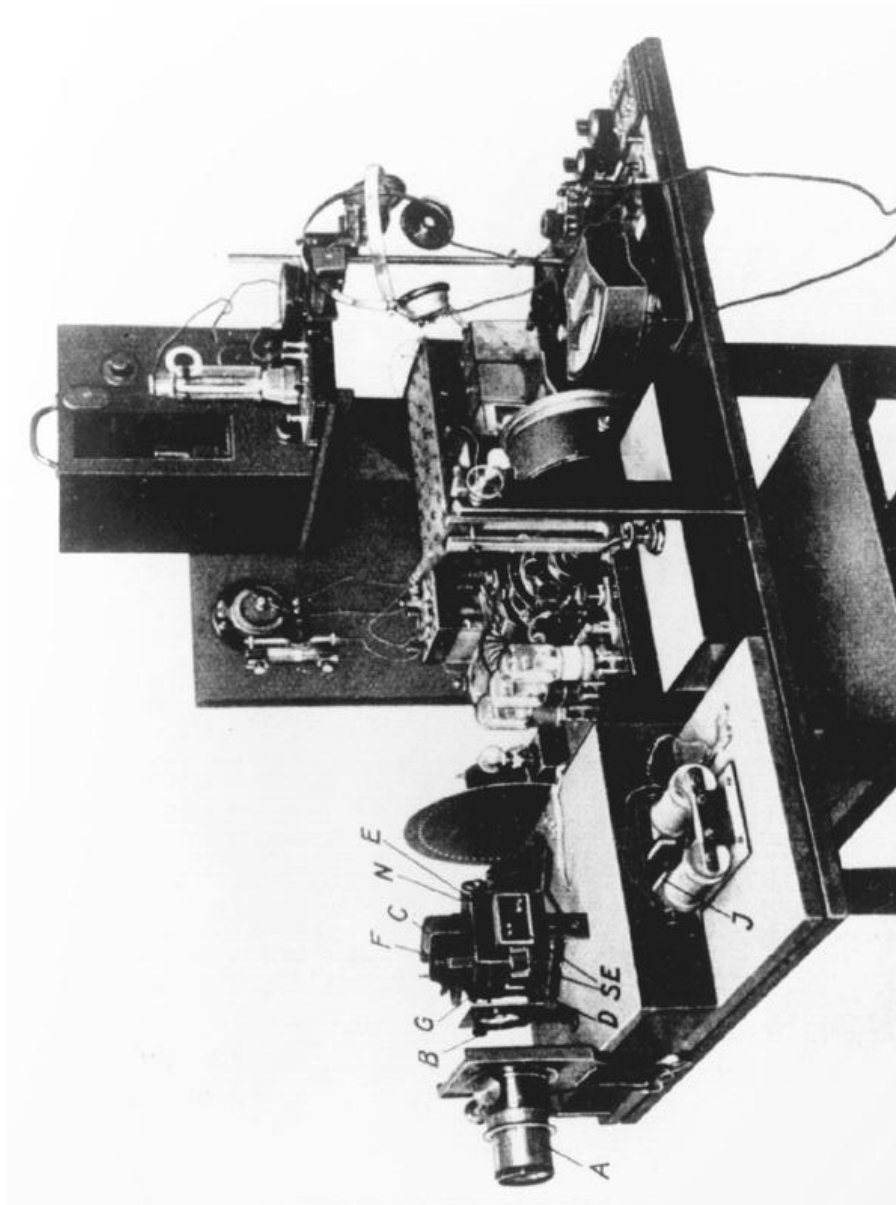
Early electro-mechanical television technology was certainly severely limited in performance, greatly limiting viable applications, but there was another problem: apart from the Scophony cinema projector there was little that was patentable and/or capable of being defended. Although high quality mechanical construction of such sub-systems as mirror drums was difficult and expensive, almost any competent company, large or small, could make them. The competition was immense, the patents were weak, the take-up was small and the returns were very low. All of this was set against the worldwide Great Depression that suppressed sales of luxury and potentially short-lived consumer durables such as television sets, however good or bad the technology. The rapid development of the new television technology based solely on the all-electronic methods hastened the fall from favour of electro-mechanical systems, whatever the application, but even without this competition it is unlikely that it would have survived apart from as a cinema industry led culture.

Potential end-users of the technology had not come forward in significant numbers to sustain electro-mechanical television. Such ‘non-users’, comprised of two relevant sub-groups of ‘resisters’ and ‘rejecters’, did still shape the direction of new developments by their non-use of the technology. These categories, as used by sociologist of technology, Sally Wyatt, in her study of internet use and non-use, can

be further broken down to specific reasons for resistance/rejection, but there is currently insufficient primary source information to analyse the ‘non-users’.<sup>329</sup> Only wireless enthusiasts and the wealthy curious ever purchased and used the products and services on the market and they did not represent the much wider potential markets. No new use was ever found for the technology as it stood and the low-definition systems had little scope for improvement without departing from the nineteenth century core ideas of discs, drums and mirrors. Commercially, in the early 1930s television industry, it was the reactions of this large group which led to the realisation that to be useful, a television system had to produce much higher definition pictures and minimise the perceived flicker. Controlling bodies such as the FRC and GPO also realised the severe limitations of electro-mechanical television, whilst also appreciating its possibilities. The technology certainly alerted industry, governments, broadcasters and the publics of all developed countries to the potential of television technology, but the real problem was finding a technology that could deliver on the promises made by the early proponents of the early systems. That fell to the new all-electronic technology that I will examine in the next chapter.

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<sup>329</sup> Wyatt, “Non-users also matter”, 76



**3.1 Mihály's Telehor of 1924 aroused considerable interest amongst other inventors as it incorporated thermionic devices to control scanning and to amplify picture signals.**

Picture source: Hungarian Patent Office Archive.

<http://www.mszh.hu/kiadv/ipsz/200306/images/07-telehor.jpg>

Accessed: 02/03/2009

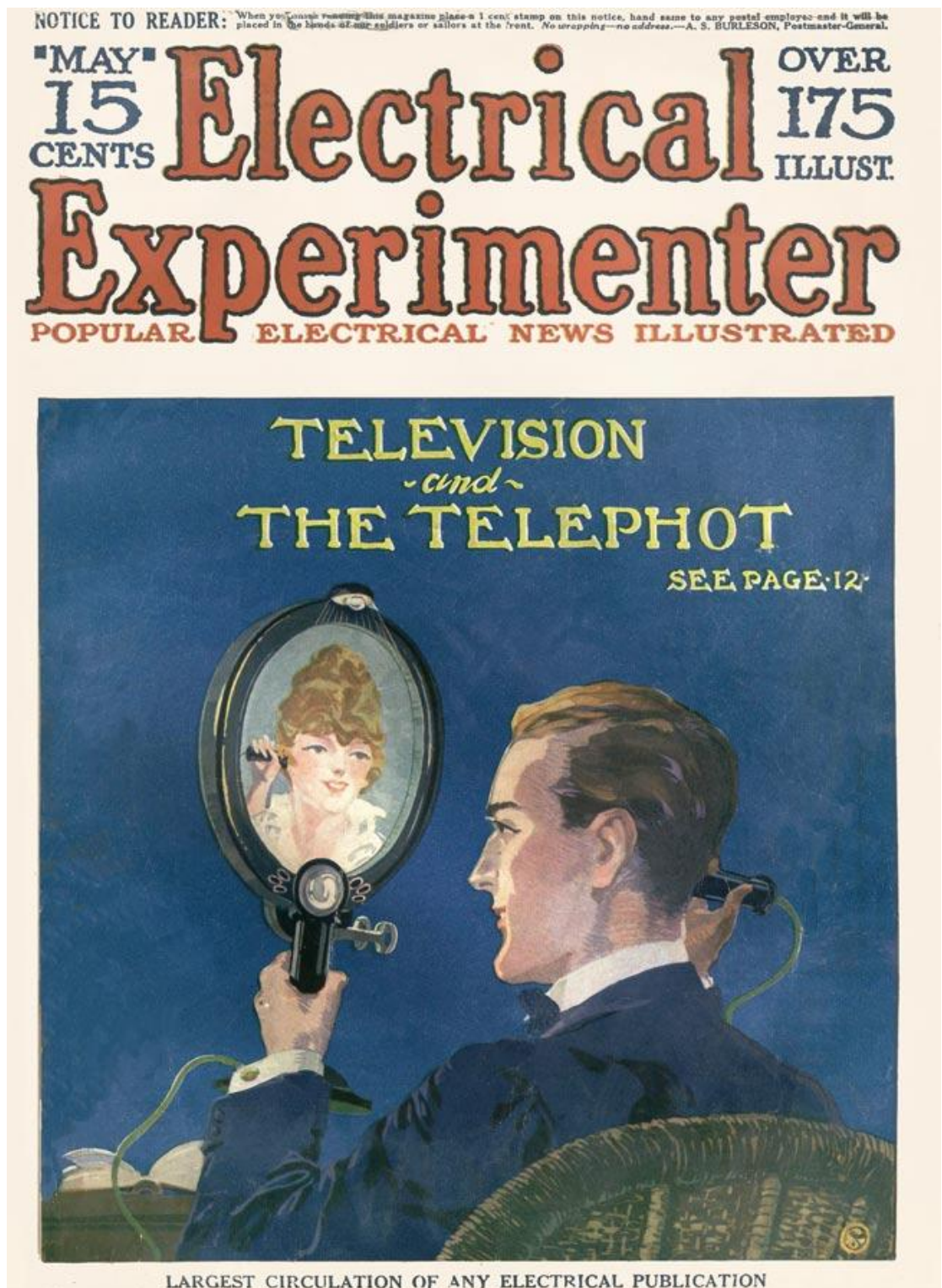


Figure 3.2 Gernsback magazine cover showing a 'Telephot' in *The Electrical Experimenter*, May 1918

Picture source: <http://www.g-books.com/> *The Electrical Experimenter*, May 1918 Accessed 03/10/2010



University of Iowa | [digital.lib.uiowa.edu/w9xk](http://digital.lib.uiowa.edu/w9xk)

**Figure 3.3** The performer's view of the television pick-up showing the bank of photo-cells in front with the Nipkow disc flying spot scanner behind and E B Kurtz of W9XK behind that. The performer would have been subjected to a very bright and rapidly moving probing spot of light.

Picture source: University of Iowa archive.

[http://digital.lib.uiowa.edu/cdm4/item\\_viewer.php?CISOROOT=/w9xk&CISOPTR=61&CISOBX=1&REC=18](http://digital.lib.uiowa.edu/cdm4/item_viewer.php?CISOROOT=/w9xk&CISOPTR=61&CISOBX=1&REC=18)

Accessed: 09/12/2009



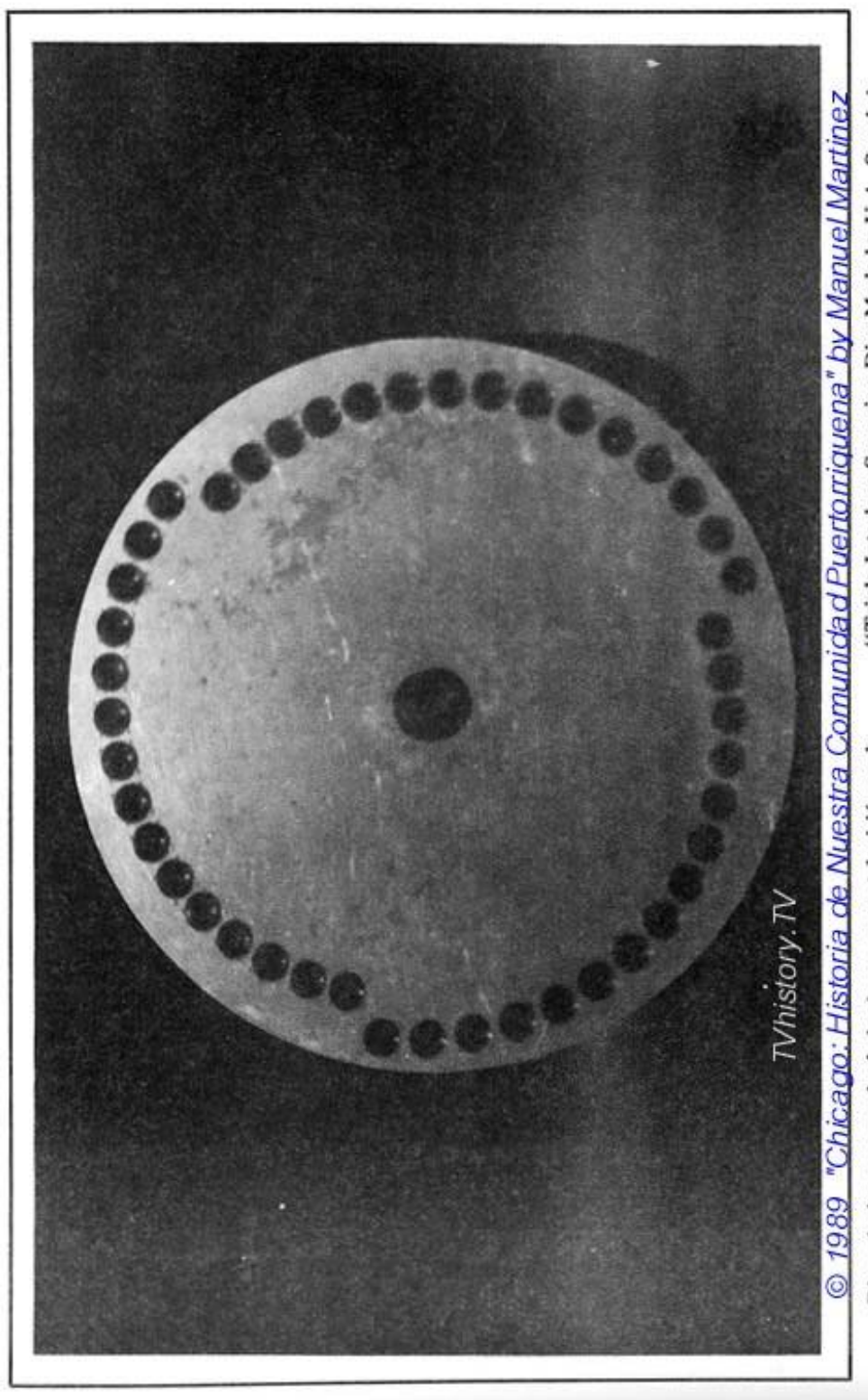


Figure 3.4 Sanabria's triple interlace Nipkow disc with three spirals. It is very difficult to see the tiny spatial offsets in the three spirals sets of holes that create an interlaced scanner for pick-up or display. Picture source: via Sanabria family at: <http://www.tvhistory.tv/disk.jpg> Accessed 12/09/2009



# Television-Added Radio Enjoyment

*You Will Be Amazed to See and Hear*

1. Your announcer
2. Beautiful Blues Singers
3. Leading stage and motion picture stars
4. Prominent public speakers
5. Dancing girls
6. Studio boxing and fencing exhibitions
7. Cartoon drawing
8. Many novelty programs

*A* Western Television Receiver will bring these programs into your home. This set operates in conjunction with your regular voice receiver. You hear the program on your own radio and see it through your television receiving set just as the artists appear before the "mike" in the studio.

## Television Operation Is Simplified

This set operates in much the same manner as any radio. Just turn the starting crank of the motor, switch on the current and then tune in your short wave receiver as you do the voice set and the studio is in your home. The set requires no more care or attention than any ordinary radio set.

## Another Added Thrill

The same short wave receiver that brings these pictures into your home also supplies keen enjoyment in the short wave broadcasts. Plug in a loud speaker . . . hear police calls from many cities in the United States.



Complete Television Set. Visionette at left, Short Wave Receiver to the right.

*Listen to the whirl of the mail planes and hear the pilot talk with air ports guiding them through the elements in their daily work. Pick up the amateurs as they converse by code or phone.*

## Description

Western Television Corporation's Visionette is a beautiful grained walnut cabinet table model, size 18"x20"x9". The short wave receiver which is shown with it in the accompanying picture is designed especially for television reception by Western Television Corporation's engineers. It is incased in a grained walnut cabinet size 14"x10"x9". Price complete, including glow lamp for Visionette and tubes for the Short Wave Receiver—\$150.00.

Those who already have a Short Wave Receiver may purchase the Visionette separately. Price \$85.00.

**WESTERN TELEVISION CORPORATION**

400 W. MADISON STREET  
CHICAGO



Figure 3.5a (top) Western Television Corp. contemporary advertisement for Western Television Visionette domestic television display, manufactured by Echophone Inc. Figure 3.5b (right) The tiny picture would be viewed through the 'porthole' with the other nautical reference, the ship's wheel, being used to adjust the picture phasing.

Picture source (Figure 3.5a):

<http://www.tvhistory.tv/western-.jpg>

Accessed: 04/05/2011

Picture source (Figure 3.5b):

<http://www.radiolaguy.com/Showcase/Western%20Television.htm>

Accessed 05/08/2009



**Figure 3.6 U A Sanabria seated in front of a flying spot scanner 1928**

Picture source: B Bochaty, great niece of Sanabria.

<http://www.flickr.com/photos/bochaty/1128389465/>

Accessed: 05/15/2009



University of Iowa | [digital.lib.uiowa.edu/w9xk](http://digital.lib.uiowa.edu/w9xk)

**Figure 3.7** Caption picture off screen of University of Iowa experimental station W9XK

Picture source: University of Iowa archive.

[http://digital.lib.uiowa.edu/cdm4/item\\_viewer.php?CISOROOT=/w9xk&CISOPTR=68&CISOBOX=1&REC=19](http://digital.lib.uiowa.edu/cdm4/item_viewer.php?CISOROOT=/w9xk&CISOPTR=68&CISOBOX=1&REC=19)

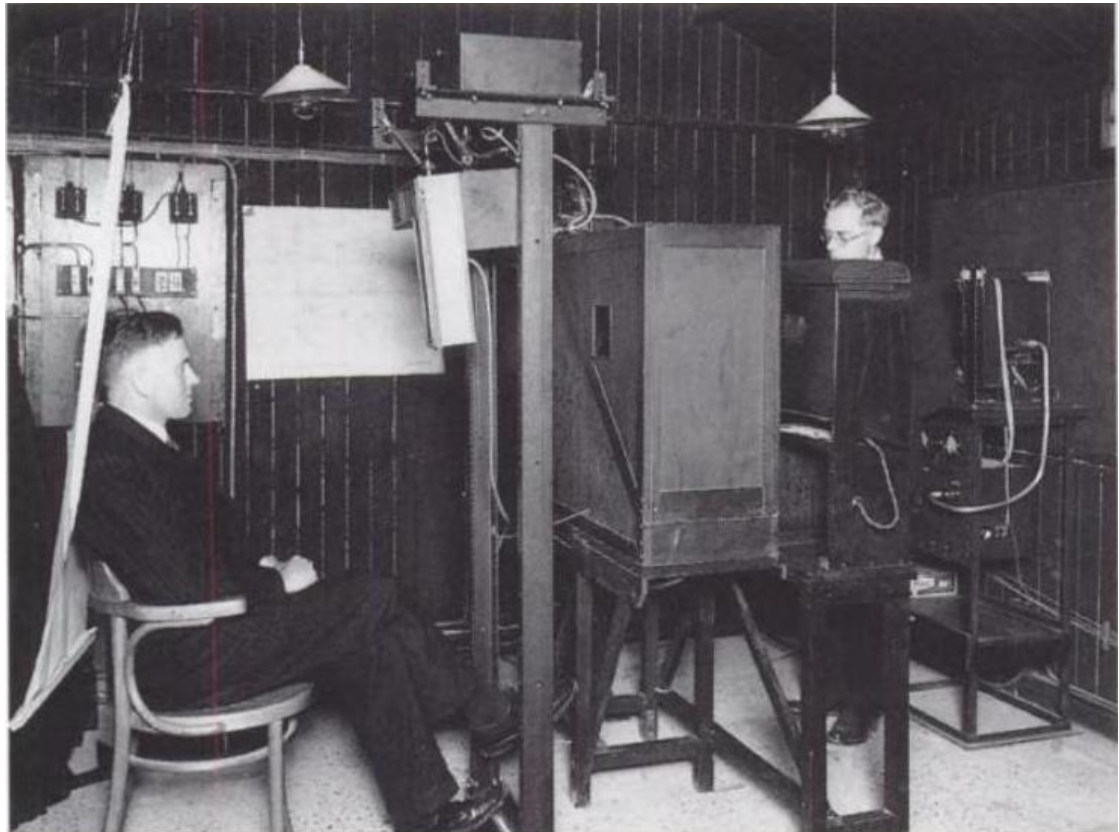
Accessed: 12/09/2009



**Figure 3.8** Off screen image from station W9XK television of a photograph of Walter A Jessup, former President of the State University of Iowa.

Picture source: Kurtz, P *Pioneering in Educational Television 1932-1939*, State University of Iowa, 68





**Figure 3.9 Chelmsford, England to Australia television transmission of 1932 showing AMA London representative A Longstaff seated in front of the Nipkow disc based flying spot scanner pick-up in Chelmsford.**

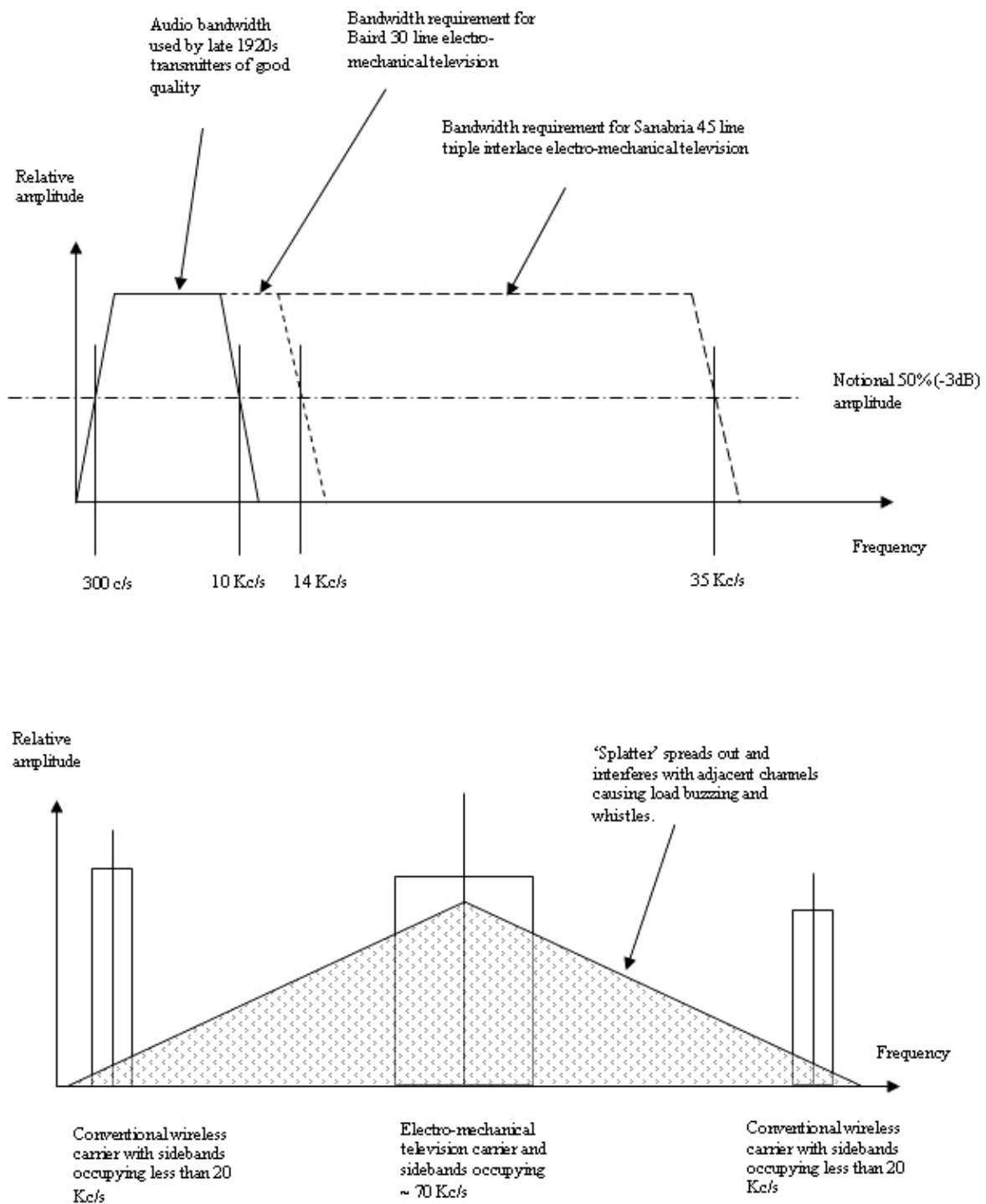
Picture source: Marconi Archive



**Figure 3.10 1938 Scophony domestic television priced at 220 Gns. Shown at the Radio Olympia exhibition.**

Picture source:

<http://www.scienceandsociety.co.uk/results.asp?txtkeys1=Radiolympia> Science and Society archive of National Museum, Science and Industry. Accessed: 12/20/2009



**Figure 3.11 Spectral bandwidth of electro-mechanical television transmissions.**

**Top:** The relative bandwidths of a sound only transmitter compared to the requirements of Western Television’s television format illustrating the discrepancy.

**Bottom:** Illustrating the bandwidths of a television channel (centre) and sound transmissions on adjacent channels. Over-modulation and/or poor television transmitter design coupled to poor receiver selectivity gave rise to the very undesirable form of interference known as ‘splatter’ or ‘blasting’.

Table 3.1								
Electro-mechanical television stations operating on the Western Television 45 line standard in the United States								
Call Sign	City	Operated by	On Air	Off Air	Lines	Frames/Second	Vision Power	Freq.
W9XX (Vision) W5XA (Sound)	Shreveport, LA	Paul L. Carriger	1929	1934	45	15		1594 kc/s (Sound)
<u>W9XAA</u> , (Vision) <u>WCFL</u> (Sound)	Chicago, IL	Chicago Federation of Labor	1928	1932	45	15	500-1000 W	2.05 Mc/s, 2.75-2.85 Mc/s, 4.88 Mc/s
<u>W9XAL</u> (Vision) KMBC (Sound)	Kansas City, MO	First National Television	1933	1935	45	15	500 W	2.05 Mc/s
<u>W9XAO</u> (Vision) WIBO (Sound)	Chicago, IL	Western Television	1929	1933	45	15	500 W	2.0-2.1 Mc/s
<u>W9XAP</u> (Vision) WMAQ (Sound)	Chicago, IL	Chicago Daily News	1930	1933	45	15	2500 W	2.1-2.2 Mc/s
<u>W9XD</u>	Milwaukee, WI	Milwaukee Journal	1930	1938	45	15	500 W	43.5 Mc/s
<u>W9XK</u> (Vision) WSUI (Sound)	Iowa City, IA	State University of Iowa	1932	1939	45	15	100 W (Vision)	880 kc/s (Sound) 2.05 Mc/s(Vision)

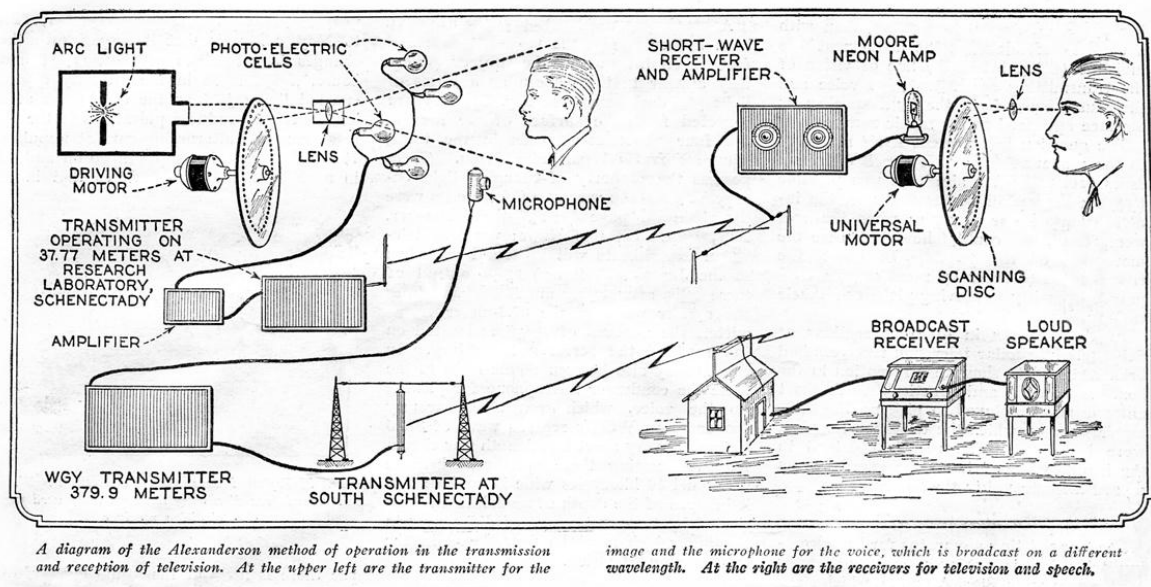
## Appendix 3.1

### The Flying Spot Scanner

The general principle of the Nipkow scanning and display proposals of 1884 was explained in Chapter 2. The following is a description of an adaptation of the Nipkow method used by most electro-mechanical television experimenters in the late 1920s and early 1930s. The invention is usually attributed to Frank Gray, of Bell Telephone Laboratories in 1926.<sup>330</sup> It was a response to the problems of extremely poor sensitivity and optical efficiency of the 'traditional' Nipkow method, obviating the need for impossibly bright scene illumination. Coupled with the new electrically fast photoelectric cells based on photoemissive principles rather than the very slow selenium photoconductive cells the technique produced a viable, if very limited, pick-up device. It could only work in darkened rooms and had a very short range severely limiting the type of scene that could be televised. A head and shoulders portrait was the method's forte.

1100

*Radio News for April, 1928*



**Figure 3.12 Flying Spot Scanner - a contemporary diagram showing the key elements of the system.**

Picture source: Radio News Vol. 9 Iss. 10, Apr 1928 1100

<sup>330</sup> Abramson, Zworykin 59

The distinguishing feature of the 'live' flying spot scanner shown in Figure 3.3 (as opposed to such a device for film scanning) is that it works with reflected light. The scanner itself appears in the top left-hand corner of the Figure 3.12 diagram and consists of three main parts: a powerful arc lamp projector (similar to the type used for motion film projection), a Nipkow disc and an array of photocells. The powerful light is broken up into a series of lines swept by the spiral train of holes on the Nipkow disc. This 'flying spot' is focused onto the scene to be televised by a projection lens resulting in the subject being televised, seeing a high intensity flashing light tracing out the scanning raster.<sup>331</sup> The reflected light from the scene is picked up by an array of photocells converting the instantaneous intensity into an electrical analogue. At any one instant of time the intense light necessary to produce a strong enough signal at the photocells is directed solely at that sample point, the rest of the scene is in darkness. In this way, the subject to be televised is saved from being continuously and evenly illuminated by such a powerful light at short range. The positioning of the photocells varies the effective 'lighting' of the subject. A photocell beneath the subject televised behaves in a similar manner to a lamp being placed there, and 'up-lights' the scene. Similarly, photocells placed at the top produced a 'down light' and those at the sides, 'side lights'. This effect was used for artistic purposes and the 'mix' of the outputs of the bank of photocells was very similar to controlling the lighting on a conventional movie set close-up scene.

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<sup>331</sup> The term *raster* is commonly used to describe the pattern of lines formed by a television scanning system, no matter what the technology that created it. The word is derived from the Latin for a rake (*rastrum*) and the term has been in use in relation to scanning systems since the early twentieth century.



## **Appendix 3.2**

### **The Interlaced Scanning Principle**

The principle of interlacing in television systems is still in use, even in the era of high-definition television. It remains a valuable technique because it reduces system bandwidth (or data rate in the digital systems of today) without sacrificing picture quality. A typical interlacing scheme is the 2:1 system whereby the system bandwidth or data rate is reduced by a factor of two without increasing the perceived picture flicker or impairing the image in any way that is detrimental to the vast majority of viewers. For critical, close up viewing applications such as computing displays, the technique has visible consequences in terms of jagged moving characters and images. For this reason computing system displays do not now use the method. Interlacing can be applied equally well to electro-mechanical and all-electronic television.

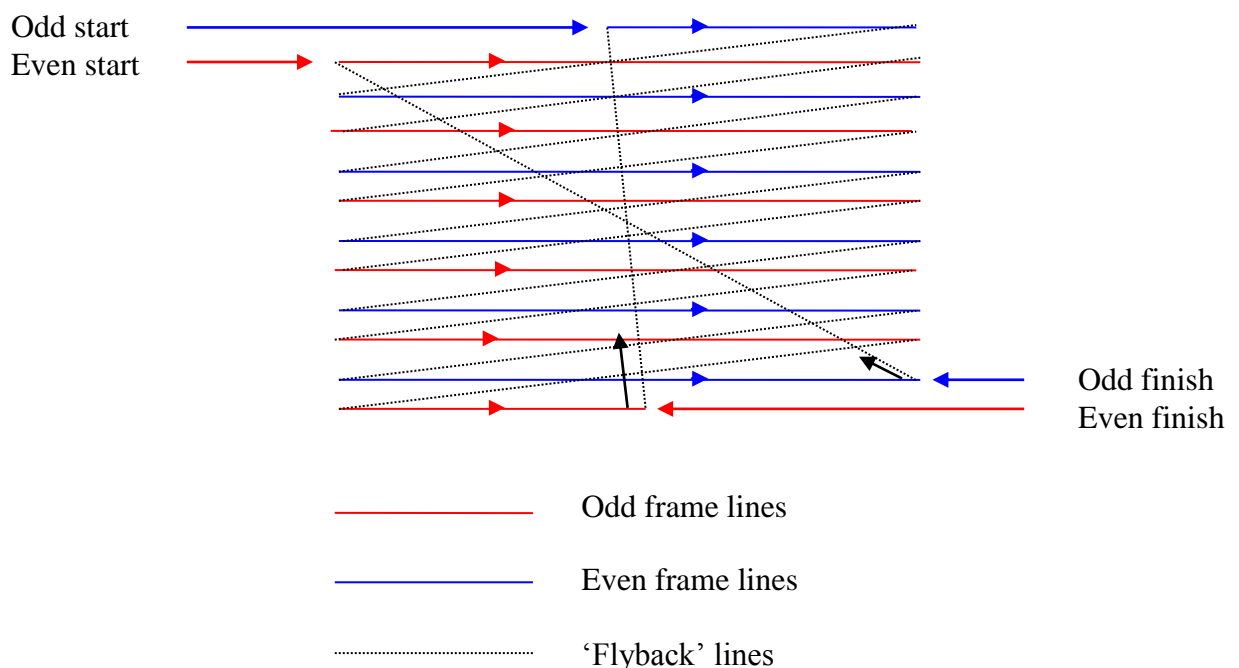
The technique, as applied to early television systems, enabled the limited system bandwidths to offer a much improved flicker rate for a given transmission bandwidth.<sup>332</sup> This was a valuable tool to enable television system designers to minimise the required bandwidth, thus saving development time and money. Most of the small extra complexity was at the transmission end of the system and therefore only required once. The changes needed in the receiving equipment were modest, almost nil.

CRT and electro-mechanical television systems exhibit flicker to varying degrees as the television image is not continuously displayed. Unlike the case of a movie projector where a still image is ‘flashed’ on the screen, the television picture illumination sweeps progressively downwards (or sideways with some electro-mechanical systems) as the television frame progresses. The individual lines making up the television picture thus only appear for a fraction of the total frame period.

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<sup>332</sup> “How Television Works”, *World Radio*. Describes interlacing and its advantages.

With reference to Figure 3.13, 2:1 interlacing works by threading odd numbered lines amongst even numbered lines in temporal order. The television frame is divided into two fields called odd and even. The odd numbered fields carry odd numbered lines (1,3,5,7 . . .) and the even fields even numbered lines (2,4,6,8 . . .). The odd frame, displayed first, paints its lines on the screen and by the time the bottom of the picture is reached the image at the top has faded. The even frame then begins writing its lines filling in between those already displayed. The eye/brain perception of this is to merge the two fields together by virtue of the persistence of vision. Using a 2:1 interlacing system the update rate of the television format can be reduced by a factor of 2 because any individual portion of the screen receives an update at twice the non-interlaced rate. In theory the technique can be extended to 3:1, 4:1 or even 5:1 but 3:1 is about the practical limit before image ‘tearing’ of moving objects becomes apparent to viewers.



**Figure 3.13 Interlaced scanning – relationship of odd and even fields for a simplified 11 line picture composed of two 5.5 line fields. Note that the half lines are only necessary in the case of all-electronic scanning for reasons to do with synchronisation and pulse generation.**

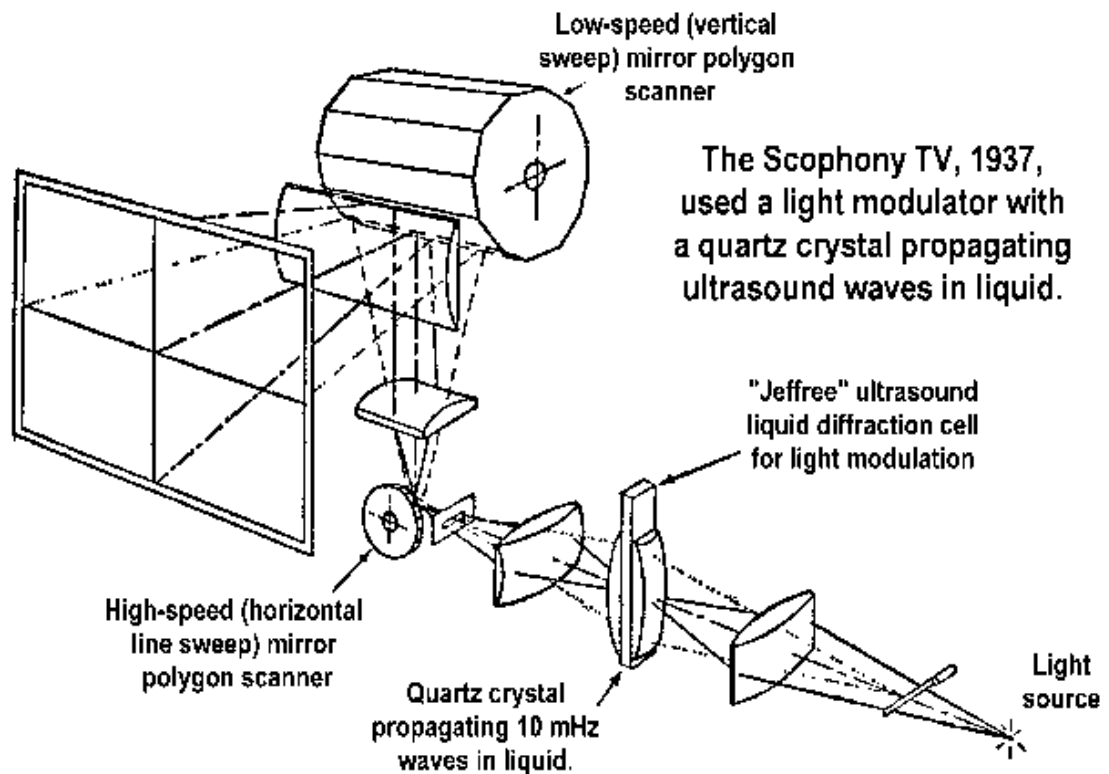
## ***Appendix 3.3***

### **Synchronisation**

Synchronisation is imperative in any television system and in an electro-mechanical system this means that the moving parts of the pick-up device accurately track the moving parts of the display device. It is analogous to two readers attempting to stay in step, following word by word, line by line and page by page. Page must track page, line must track line and word must track word. In the case of a Nipkow disc with a 'fixed' spiral scanner of holes it is only necessary for the speed of the pick-up and display discs to be identical, and that the first hole passes a reference mark at exactly the same time to establish phasing. Scanning along the line is continuous, produced by the motion of the disc, and once the discs have been locked in speed and phase this condition follows by default. This process has been known as synchronisation since the earliest developments of still picture scanners and faxes. There are two approaches to keeping the discs in synchronisation: either the speed and phase must be controlled by a separate feedback control loop continually monitoring and correcting the speed/phase, or the rotating system can inherently be in step by design. In a simple laboratory set up, as used by the early Nipkow disc television experimenters, the pick-up and display discs simply shared the same motor shaft. Synchronisation was inherent as they were physically linked, but separating the discs to achieve real 'distant vision' necessitated another technique. Most inventors and researchers had opted for a system of active control, complex and difficult as it was with 1920s technology.

## Appendix 3.4

### The Scophony system



**Figure 3.14** Principal parts of the Scophony electro-mechanical television display system.

Picture source: Long, C Light modulation via ultrasound.

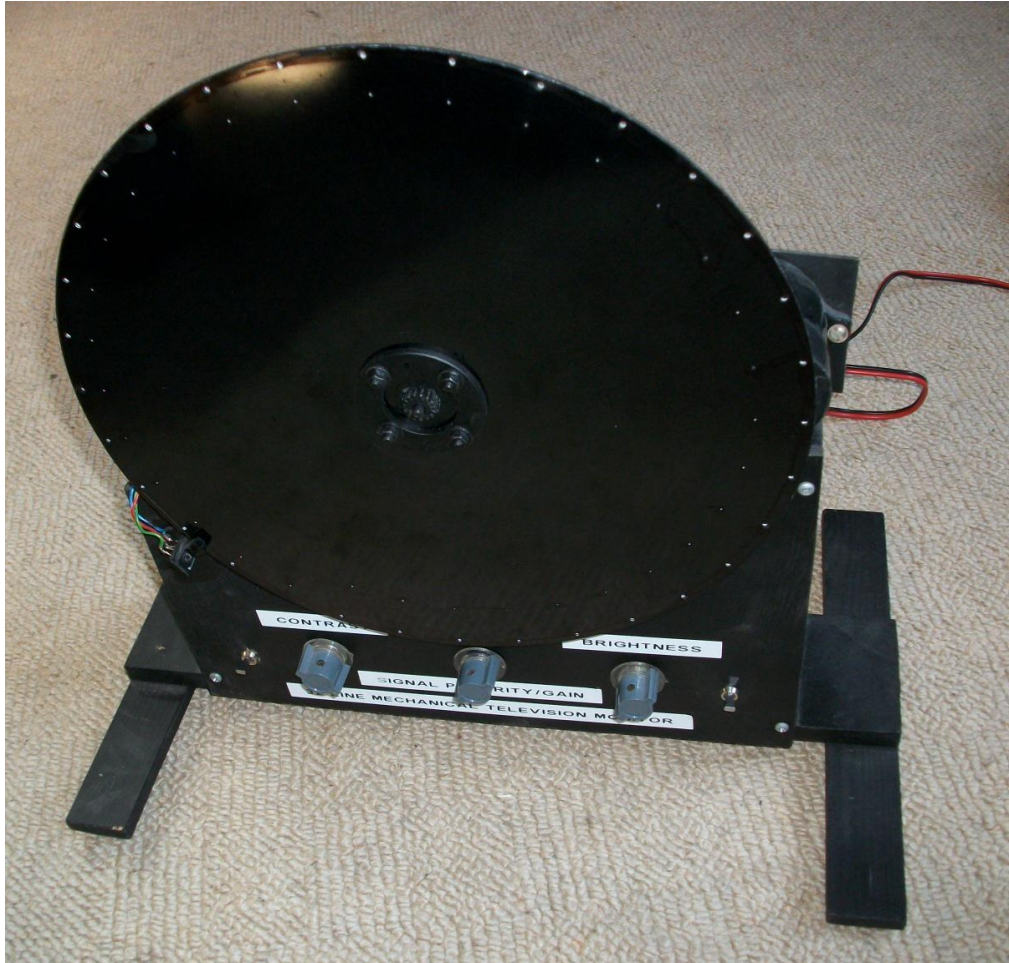
<http://www.modulatedlight.org/.../UltrasoundMod.html> Accessed: 12/20/2009

Unlike self-emissive CRT display systems based on phosphors, the Scophony method had as a light source a normal projection type arc lamp such as a Mercury type. The light was optically formed into a long thin line and imaged onto an opto-acoustic modulator using a cylindrical lens. The modulator consisted of a cell, containing a liquid such as heptane, which can be modulated in instantaneous density by a quartz piezo electric transducer driven by the picture intensity information modulated onto a radio frequency carrier. This supersonic modulation of the liquid medium produced diffraction patterns in response to the picture information. The propagation velocity of the acoustic signal through the liquid was sufficiently slow that one whole television line was effectively 'stored' in the cell. The diffraction

patterns were resolved into modulated light by means of an optical slit. The resulting modulated television line was scanned by a high speed drum scanner to produce a fully modulated and scanned line. Finally, the sequential line patterns were separated out into a full-height picture by scanning at low speed with another drum scanner focussed upon the screen in the vertical plane by cylindrical lenses.

## ***Appendix 3.5***

### **Nipkow disc replication**



**Figure 3.15 Nipkow disc receiver**

In order to appreciate first-hand the difficulties of the Nipkow disc, I have built a working model. There have been many of these made over the last decade by enthusiasts, but my goal was to make the unit out of as many basic parts as possible, as it would have likely been made in the early 1930s. The disc was marked out and cut by hand. It is made of ‘Traffalite’, a proprietary thermosetting plastic in layers which keeps the disc relatively flat and is easy to work. Traditionally this would have been aluminium, but this concession to modern materials did not detract from the basic scheme. Results are, as could have been predicted, as the contemporary photographs show, and similar to Figure 4.1

## Chapter 4.

### *Television with tubes: networks of dissemination*

#### **4.1 Introduction**

In Chapter 2, I described how writers, inventors and scientists were beginning to speculate about what a system called ‘television’ might do, and how it might be created. In Chapter 3, I examined the practical realisation of electro-mechanical television using three distinct commercial case histories. All three companies’ systems ultimately fell into disuse, despite one of them (Scophony) producing considerably better picture quality than the ‘standard’ electro-mechanical techniques used by the other two. The three were each targeting different markets: cinema, broadcast and specialist applications. Their efforts, and those of their many rivals, to commercialise electro-mechanical television fell by the wayside, not solely due to poor performance, but because of commercial and political aspirations for a newer television technology. The new technology was all-electronic and used cathode ray tubes (CRTs), having its origin in suggestions made at the beginning of the twentieth century.<sup>333</sup>

This chapter reviews a period in the history of all-electronic television from around 1900 to 1932, during which time the initial ideas were disseminated around the world, and then developed by a small number of individuals and companies. The later stage of this process overlapped the attempted commercialisation of electro-mechanical television, and the stark realisations then dawning about how good a television picture had to be for it to be accepted by the public. A typical electro-mechanical picture at that time consisted of 30 lines, was very dim, about an inch square and had a pronounced flicker (see Figure 4.1). The picture quality offered by electro-mechanical television systems did not measure up to that seen in any cinema, and once the novelty had begun to recede, it was often this very unfavourable

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<sup>333</sup> The term ‘electronic’ is older than might first be imagined, dating back to the 1920s in relation to vacuum tubes and then ‘hijacked’ by other engineers in the early 1930s. See: Wilkes, “Growth of electronic Engineering”, 1.

comparison which was reported by journalists and writers.<sup>334</sup> A BBC Internal Circulating Memo of 1928, written by the Corporation's Assistant Controller, W E Gladstone Murray, was highly critical of electro-mechanical television. He reported that criticism of such a system '... has recently been thoroughly endorsed by no less an authority as (sic) Sir Oliver Lodge'.<sup>335</sup> In matters of wireless technology, Lodge was a very important authority figure, being a wireless pioneer from the turn of the century, author of numerous articles and a regular broadcaster on BBC wireless.<sup>336</sup>

To the individual inventor and small companies with limited resources, developing a television system based on electro-mechanical techniques was the most amenable to develop in the 1920s, because it was possible to build and experiment with such systems without huge facilities and financial outlay. Even larger companies found the technology to be the most expedient, attempting to use their technical and corporate power to forge a lead. No company or inventor had produced a television system of a technical standard useful for any serious purpose and how good it had to be was still unknown. By the late 1920s, learning from the experience and knowledge of the electro-mechanical television pioneers, a realistic target for the required technical performance of a television system was emerging, even though there were no definitive technical specifications. This process was being shaped by ideas about what television could be used for, and where it might be deployed, be it in the home or in the cinema. By the mid-1930s, the performance and capabilities of electro-mechanical television systems were approaching a ceiling (with the possible exception of Scophony); but there was another, potentially better method of television which could overcome the speed limitations of the mechanical systems.

In the first decade of the twentieth century, British engineer-scientist, Alan Archibald Campbell Swinton and Russian scientist Boris L'vovich Rosing, could see an alternative to the inherently slow scanning (which led to very low picture detail and fidelity) of the then still largely theoretical electro-mechanical schemes. Both men were proponents of using the still very new CRT for receiving (display)

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<sup>334</sup> Dunlap, *The Outlook for Television*, 232; Peck, "Perfect Detail in Television?".

<sup>335</sup> Murray, "The Truth About Television", BBC Written Archives.

<sup>336</sup> Rowlands, "Lodge, Sir Oliver Joseph".



purposes, but Campbell Swinton's proposals went beyond the display. His suggestion involved the other key element of a television system, a viable television camera or 'transmitter' as he then called it. Campbell Swinton's concept of a complete 'distant electric vision' system with no moving parts first appeared in 1908 in a letter to *Nature*, whilst almost simultaneously Rosing's ideas appeared as patents in Russia, Germany and Britain in 1907/8. Their proposals gained little traction in the first two decades of the twentieth century, although the ideas were disseminated throughout the world via articles in journals, magazines and periodicals. Both shared the same problem: the contemporary supporting technology of 'electronics' was insufficiently developed for either of them to take the concept much further in a practical way.

Following the great advances in thermionic valve technology and circuit techniques during the Great War, further enhanced by the wireless boom of the mid-1920s, all-electronic television attracted renewed interest. Initially, the proposed technology had few proponents, and even fewer actually engaged in practical work. This altered rapidly in the late 1920s and early 1930s with the continuing disappointing progress of the electro-mechanical techniques stimulating interest amongst inventors and investors in alternatives. The initial practical efforts to develop all-electronic television followed two paths in the United States: one by a former student of Rosing's, Russian émigré scientist Vladimir Zworykin, working for RCA, and the other by an independent inventor from Utah, Philo Taylor Farnsworth. Parallel work was also taking place in the Soviet Union by a small team of scientists working in Tashkent in the Republic of Uzbekistan. More specific work on receiving CRTs was also being carried out in Japan, Germany, France and Britain, but nothing of a practical nature with regard to pick-up tubes. From a very small base in the late 1920s, all-electronic television became viable in a very short time, powered technically by developments in wireless and electronics, and commercially as an answer to the increasing frustrations, broken promises and disappointments of electro-mechanical television.

RCA lies at the heart of the established story, and backed by the formidable financial and technical resources of the corporation, Zworykin began, in 1929, the development of a photoemissive pick-up device, the iconoscope, and a matching

receiving CRT, (the kinescope). Practical results were demonstrated by 1932, when the complete system was shown in confidence to government bodies such as the Federal Radio Commission (FRC) and some RCA-affiliated companies. The successes were kept secret, but eventually released to the public in early 1933, making headline news in the *New York Times*.<sup>337</sup> This achievement resulted in confidence that all-electronic television could be developed to a high standard, and beyond 1932, the development effort moves from individuals and very small teams to corporate industrial laboratories making extremely rapid developments.

In terms of television systems which could be presented to the public, there never was any real 'choice' between the all-electronic and electro-mechanical versions. The notion that there was a choice was suggested in a paper by Jan van den Ende et al surveying the early development of television,<sup>338</sup> but this work fails to take into account the very severe technical limitations of electro-mechanical television that were well known at the time, and fully reported in the contemporary lay and technical press.<sup>339</sup> This shaping of television technology was by companies, committees and institutions rather than by the end users and consumers.

In the early 1930s, television was being critically examined as a potential new medium, both technically and commercially, by broadcasters, wireless manufacturers, the film industry, governments and regulators such as the British Post Office (GPO) in Britain and the FRC in the United States. In Britain it was for the GPO, the BBC and the British Government to decide television policy, not the public. In the United States, the same was also largely true, but the effects of the Great Depression weighed more heavily on the American wireless industry. It did not want hints of a new technology, 'wireless with pictures', to damage sales of existing sound only sets, a theme which I will examine more closely in Chapters 5 and 6. Governments and regulatory authorities not only had the choice between

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<sup>337</sup> Laurence, "Human-Like Eye", 1933, also see Figure 4.7.

<sup>338</sup> Ende, Ravesteijn, and Wit, "Early Development of Television".

<sup>339</sup> "So Near and Yet So Far", *New York Times*, 1931; "A Demonstration of Television", *Guardian*, 1935; "Television Plans", *The Times*, 1931; "'Looking In' - The Present and the Future", *The Observer*, 1935; Appleton, "Television - Translation of Light and Shade - Stages in a Complex Process", Aug 14 1934.

electro-mechanical and all-electronic systems, but also between competing detailed techniques and systems then in development. Commercial interests did have some influence, but it was ultimately not purely a commercial decision.

I will begin by briefly summarising the history of the CRT up to the Great War, describing the contemporary applications for the device, its practical difficulties and its continued development path beyond the early 1900s, by which time it had become established in a few specialist fields. I will then engage with the narratives of the two principal pioneers of CRT based television: Campbell Swinton and Rosing. Their ideas overlap in terms of technology and chronology, and it is impossible to know from the available information whether there was any communication between the two. This could be a case of independent simultaneous invention (simultaneity) occurring in similar cultural circumstances, or it could be related to some unknown communication and/or earlier idea. I will show that it is likely to be the former, which concurs with the school of thought, founded by American sociologists William Ogburn and Dorothy Thomas, about the highly likely occurrence of simultaneous invention. Sociologists D K Simonton, A Brannigan and R A Wanner have approached the controversy of simultaneity using statistical mathematics, suggesting that the statistical likelihood for this kind of invention is high.<sup>340</sup>

Campbell Swinton shaped the development of television in two ways: firstly as a proponent of his own proposals for television based on cathode ray technology, and secondly as a fierce critic and opponent of electro-mechanical techniques. He was a well-known figure within the world of British science and engineering, and working through his extensive network of friends and colleagues, he was able to counter, at least within Britain, many of the claims of Baird and his associates. Much of the narrative surrounding Campbell Swinton's active opposition is probably lost, but there is some evidence in the form of private and public letters.

I will then address Rosing's initial developments in pre-revolutionary Russia, and how this work was effectively pursued in the Soviet Union and in the United States.

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<sup>340</sup> Ogburn and Thomas, "Are Inventions Inevitable?", 92-93; Simonton, "Independent Discovery in Science and Technology"; Brannigan and Wanner, "Historical Distributions of Multiple Discoveries".

The details of Rosing's work is equally difficult to find, as being an active White Russian dissident, his life, home and work were subject to much disruption after the Russian Revolution. I will explore how Rosing's student, Zworykin, carried the ideas to the United States, probably incorporating Campbell Swinton's CRT pick-up concepts into the Rosing scheme. I will then describe the formation of the RCA team which produced a successful CRT based pick-up device and a viable receiving display, creating a near fully viable all-electronic television system by early 1933. I will continue by examining how Rosing's work was carried on in the Soviet Union by a small group in Tashkent in Uzbekistan, pursuing a path at odds to the route propagated by Zworykin and RCA, using photoconductive rather than photoemissive pick-up technology. This work represents a divergence from the path pursued by RCA, and even if the level of their success is debatable, it confirms that CRT-based pick-up tubes did not inevitably have to be similar to Zworykin's invention.

Zworykin is often described as the 'father of television' in the American press and television industry,<sup>341</sup> but he has a rival for that title in Farnsworth,<sup>342</sup> the inventor of an all-electronic pick up device, the image dissector, which was not strictly a CRT. I will continue by examining Farnsworth's work, how his invention was shaped by interactions with RCA, and how his work impacted upon the development of the iconoscope. To complete this review I will then briefly examine contemporary developments in the rest of the world as part of a summary of developments in all-electronic television technology as of 1932. This will establish that the development of all-electronic television occurred in a number of companies and organisations, with no one technology appearing to be dominant or inevitably superior. These developments fundamentally shaped the direction of television, but there was nothing inevitable about the choices taken.

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<sup>341</sup> Abramson, *Zworykin*, 1.

<sup>342</sup> Godfrey, *Philo T Farnsworth*.

## **4.2 The development of the cathode ray tube to 1910**

*Kathodenstrahlen* (cathode rays), so named by German physicist Eugen Goldstein in 1876, are the ‘rays’ (now known to be electrons) emitted by the negative electrode (the cathode) in a low gas pressure or partial vacuum discharge tube, as first observed by German physicist Johann Hittorf in 1869.<sup>343</sup> By the late nineteenth century, the electrical conduction of gases was a field of physics attracting the attentions of British scientists such as Lord Kelvin, J J Thomson and James Clerk Maxwell. Thomson’s work, using electrostatic deflection of cathode rays in his experiments to determine the mass to charge ratio ( $m/e$ ) of the particles forming the cathode rays (electrons), became associated with a special form of CRT in the mid-1890s.<sup>344</sup> His tubes relied on a pair of collimating slits to produce a single line on a screen which could be deflected by a magnetic field or an electric field, producing information from which  $m/e$  could be determined.<sup>345</sup> The CRT of the mid-1890s was a rare but established tool for scientific exploration, as well as being a technical curiosity in its own right, with many reports of experimental work appearing in journals and magazines.

Another stimulus to CRT development was the discovery of X-rays in 1896 by another German physicist, Wilhelm Conrad Röntgen. X-ray tubes have much in common with early CRTs, requiring very high voltages to produce a focused electron stream in a vacuum, or in a low pressure inert gas. With the important uses of X-rays in medicine being recognised almost immediately, development work ensued to increase image quality by improving the focus and the power of the electron stream hitting the X-ray tube target. Much of the knowledge gained in the development of X-ray tube technology was useful to scientists working with CRTs. Both tubes used cold cathodes, that is, the cathode was not heated to encourage the

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<sup>343</sup> Hittorf, “Ueber die Elektrizitätsleitung der Gase” This two part paper describes the cathode phosphorescent ‘glow’ on the glass wall of a discharge tube and how shadows were cast by solid objects near the cathode.

<sup>344</sup>  $m/e$  is the mass ( $m$ ) to charge ( $e$ ) ratio of an electron. Thomson showed that this value is a constant, independent of the cathode material, thus establishing the emitted particle (the electron) as being fundamental.

<sup>345</sup> Thomson, “Cathode Rays”, 296.

emission of electrons, and in the case of the CRT, this meant that in order to produce a visible spot on the CRT screen, very high accelerating voltages similar to those needed for X-rays had to be used - in the region of 50 kilovolts and beyond. CRTs of this type, usually referred to as being 'hard', were difficult to focus, relying on slits or the ionising effects of the very low gas pressure and they were erratic in operation.<sup>346</sup> Numerous turn of the century publications about X-rays, N-rays, canal rays (positive ions) and cathode rays, all stimulated further interest in CRTs amongst physicists.<sup>347</sup>

Improvements to the original CRT scheme followed as other scientific uses were proposed. German physicist, Professor Karl Ferdinand Braun's innovation of 1897 was to add a diaphragm (pinhole) and an efficient fluorescent screen to a Thomson CRT. This resulted in a brighter, sharper circular spot which could be moved around on the screen either by electromagnets or by electrostatic deflection plates. By the early 1900s, the Braun tube had found a use as a high speed oscillograph, able to plot electrical variations in amplitude much faster than the usual electro-mechanical pen recorders.<sup>348</sup> Figure 4.2 shows a selection of sample oscillograph photographs taken in 1899 by German oscillograph developers Arthur Wehnelt and Bruno Donath. The device was further developed to improve its spot size (focus), brightness and deflection capability to facilitate this application, improving the visible detail and speed of response. Fellow German scientists, Dr. Max Dieckmann and Gustav Glage, used a Braun tube to create a form of 'distant writing' machine that could

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<sup>346</sup> The use of the description 'hard' is confusing – in early use in describing CRTs and X-ray tubes it refers to a cold cathode device working with very high voltages to produce very energetic electrons to produce cathode rays and 'hard' (as opposed to 'soft', or longer wavelength) X-rays. In later and current use, the term 'hard' refers to thermionic valves and CRTs having a 'hard' vacuum, as opposed to a 'soft' tube or valve which is gas filled. Further explanations can be found in: Bedford, "Soft and Hard Cathode Ray tubes" This paper explores the differences between 'hard' and 'soft' (vacuum and gas filled in this case) CRTs and explains the focusing action of the two types.

<sup>347</sup> Nye, "N-Rays", 130 describes the interest in scientific circles of all types 'ray', particles and emissions around the turn of the nineteenth century.

<sup>348</sup> Wehnelt and Donath, "Photographic Display of Current and Voltage", 6. Depicts photographs of oscillographs taken from the screen of a Braun tube (CRT).

follow the actions of a pencil and reproduce the paths traced on its screen, which they patented in 1906.<sup>349</sup>

Even in its ‘hard’ form, the CRT of the early 1900s was an established and developing device, though its applications were limited and specialised. Using the CRT as the core technology for a ‘seeing at a distance’ machine was not an obvious application, especially in terms of the pick-up for such a system. I will now describe the beginnings of Campbell Swinton’s concept of CRT-based all-electronic television, and how this idea gained traction throughout the world, benefiting greatly from his well-established network of friends and associates within the British scientific community.

### ***4.3 Campbell Swinton and his scheme for ‘distant electric vision’ with no moving parts***

Campbell Swinton is important in the invention of television for two reasons: firstly his proposals for distant vision with no moving parts, and secondly, his later vehement opposition both publicly and privately, to electro-mechanical television technology. Neither his idea, nor his opposition, were particularly well known in his lifetime, but his influence on the technical and commercial direction of television in the early 1930s can be demonstrated through careful review of the very limited surviving primary sources. Unfortunately, the Campbell Swinton family archive has little relevant information beyond his published works, and few other records have come to light. Campbell Swinton died in 1930, a few years before the importance of his work was fully recognised; the bulk of his private papers were probably destroyed in the Blitz, or perhaps in a house fire.<sup>350</sup> His opposition to electro-mechanical television, made forcibly to influential figures in science, business and the BBC, contributed to the Corporation’s lukewarm embrace of Baird’s technology. His influence is recognised in virtually all works on the early history of television,

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<sup>349</sup> Dieckmann and Glage, “Verfahren zur Übertragung von Schriftzeichen und Strichzeichnungen unter benutzung der kathodenstrahlenrohre”, Patent No. 190,102.

<sup>350</sup> Campbell Swinton’s home at 40 Chester Square, London, remained in the family after his death but was destroyed by World War II bombing. The family home in Berwickshire was also heavily damaged by fire in the mid-1930s. Many papers are assumed to be lost.

even in Russian secondary sources written in Cold War times, but virtually no detail of his own experimental work and private correspondence survives.

#### **4.3.1 Campbell Swinton and his networks of influence in British science, engineering and commerce.**

Campbell Swinton was born in Edinburgh in 1863 into a minor upper-class family. His early childhood was spent in Berwickshire, Scotland, at the family home of Kimmerghame (pronounced Kimmergin), close to Duns and not far from the village of Swinton which bears the family name. His authorial debut came at the age of 15 with an article about one of his great passions, photography, published in the *British Journal of Photography* in 1878.<sup>351</sup> After leaving school with no qualifications, he spent 9 months in France, practising the language and visiting the 1881 Electrical Exhibition in Paris, returning home to begin an apprenticeship with the firm of Sir William Armstrong, shipbuilder, at Elswick, Newcastle upon Tyne. His work there was primarily with regard to electrical installations and lighting, leading to the publication of his first book, *Elementary Principles of Electric Lighting*, which was written two years after he had started at the firm, and whilst he was still an apprentice. It became a standard text in electrical engineering, being reprinted several times.<sup>352</sup>

After completing his apprenticeship in 1887, during which time he had successfully introduced electric lighting to warships, he left the shipbuilder to pursue an independent career in electrical contracting and consulting, setting up an office in London. The work was mainly concerned municipal lighting projects and electric traction, but was supplemented with other contracts outside the field of electrical engineering. These activities included working on steam turbines with engineer Sir Charles Parsons, becoming a founder-director of Parson's Marine Steam Turbine Company, the company which, in 1894, produced *Turbinia*, the successful proof of principle turbine-driven boat. His other company directorships included telegraph cable manufacturer, W T Henley Ltd., electrical equipment manufacturer, Crompton

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<sup>351</sup> Swinton, "My Dark Tent".

<sup>352</sup> Swinton, *Principles of Electric Lighting*.



& Co. Ltd. (director from 1913, chairman from 1915) and mechanical engineers, Engine Patents Ltd. (co-founder and chairman from 1915).

By the end of the nineteenth century, Campbell Swinton was moving from being primarily a practical engineer to becoming an engineer-scientist, consulting in many fields, and having the personal resources to pursue non-commercial private interest investigations. An example is his work on what he called ‘New Photography’ (X-rays), beginning with the production of a ‘shadow photograph’ of his own hand in 1896, only weeks after the disclosure of the discovery by Röntgen. The achievement was well publicised, leading to a whole new area of personal expertise, resulting in the opening of his own X-ray consultancy for medical and industrial applications in London in 1897.<sup>353</sup> Another interest was the new field of wireless, which became a long term fascination, and it was Campbell Swinton who introduced the young Marconi to the Chief Engineer of the Post Office, William H Preece in March 1896, beginning Marconi’s career in Britain.<sup>354</sup> During the early 1900s, Campbell Swinton’s numerous scientific interests and private research gradually replaced his work in electrical consultancy, effectively creating a second career, but despite this shift he still appears to have regarded himself as an engineer, not as a scientist.<sup>355</sup>

Campbell Swinton’s scientific work grew from, but was not limited to, his electrical engineering competencies, producing original research in several fields and bringing him into contact with many of the leading British physicists and chemists of the late nineteenth century. His investigations into canal rays, cathode rays, X-rays and producing diamonds from coke using high pressures yielded papers communicated to the Royal Society on his behalf.<sup>356</sup> More practical work on topics such as high

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<sup>353</sup> Swinton, “News item” Reports that his new Röntgen Photography laboratory will be open for medical investigations the following week.

<sup>354</sup> Baker, *A History of the Marconi Company*, 88.

<sup>355</sup> In the 1901 census he styles himself as ‘Engineer’, and in the 1911 census as a ‘Consulting Engineer’. The 1914 edition of *Who’s Who*, 2080 and 1926 edition, 2828, both tally with the 1911 census in this regard.

<sup>356</sup> Examples of the many communicated papers are: Swinton, “Experiments with Cathode Rays”. Communicated by Lord Kelvin; Swinton, “Diamond into Coke”. Communicated by the Hon. Charles A Parsons.

voltage discharges and the production of cathode and Röntgen rays resulted in lectures to learned societies and articles for journals.<sup>357</sup> Campbell Swinton was known as a particularly diffident man, following the traditions of a gentleman scientist, and he became deeply involved with the established networks of early twentieth-century British science.<sup>358</sup> He was elected as a Fellow of the Royal Society (FRS) in 1915, an honour which, according to one of his assistants, Robin Houston, was ‘undoubtedly the event in his life which gave him most pleasure’.<sup>359</sup> This opinion is further evidenced by a self-penned cartoon of himself in heaven (Figure 4.3).

Amongst his many other professional associations, Campbell Swinton was an active member of all three British engineering institutions, the Mechanicals, the Civils, and the Electricals (of which he was vice president 1921-25), a regular attender of the Athenaeum Club in London (elected 1901), chairman of the Royal Society of Arts (1917-19 and 1920-21), first president of the London Wireless Society (1913-20), a manager of the Royal Institution (1912-15), president of the Smeatonian Society of Civil Engineers, a Freeman of the city of London (1920), Liveryman of the Goldsmiths Company and president of the Röntgen Society. A further appointment in 1924 was his membership of the Broadcasting Board, set up by the Sykes Committee, as part of the control infrastructure for the British Broadcasting Company, bringing him into direct contact with the board’s chairman, the BBC’s founding General Manager, John Reith.<sup>360</sup>

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<sup>357</sup> Examples of his lectures and journal writings are: Swinton, “Electrical Discharges” Details a presentation made to the British Association in 1892; Swinton, “Cathode and Röntgen Radiations”

<sup>358</sup> Swinton, *Autobiographical and Other Writings*, 172. An obituary notice bound into the autobiography, published shortly after his death, describes his modesty. This was written by ‘R.H.H’ – almost certainly Robin Henry Follett Houston (the ‘F’ often being omitted in his initials), a close friend and former laboratory assistant of Campbell Swinton. Houston was managing director of vitreous enamel insulator manufacturer, Thermal Syndicate Ltd. by the time of Campbell Swinton’s death.

<sup>359</sup> Ibid.

<sup>360</sup> The Sykes Committee was set up in 1923 by the British Government to consider the BBC monopoly and how the company was being operated. See: Briggs, *The Birth of Broadcasting*, 247.

Campbell Swinton's many friendships with the leading physical scientists of the late nineteenth-century through to the late 1920s suggest him to be a very well-known figure, being very active both socially and professionally. His hobby of photography yields many surviving informal after-dinner group and single portraits of friends. One such series, taken at the home of physicist Sir Andrew Noble, featured the host with (at different dinners), Sir James Jeans, Sir Charles Parsons, Sir Frederick Bramwell, Sir J J Thomson, Sir William Bragg, Lord Kelvin and many others.<sup>361</sup> Other men of science such as Sir Oliver Lodge, Lord Armstrong, Lord Rayleigh, Sir William Crookes, and others were photographed at Campbell Swinton's home and at the Athenaeum Club.<sup>362</sup> In 1924, he described some of these friendships in a paper which consisted of reminiscences about 'notable scientific men', liberally mentioning acquaintances and meetings with well-known figures such as Edison, Bell and Marconi.<sup>363</sup> Campbell Swinton's career, expertise and network of associates ranged widely, spanning engineering and the physical sciences, bringing him into contact with many of the leading figures in late nineteenth century British science and engineering.

#### **4.3.2 Distant electric vision with no moving parts – the idea and its dissemination.**

Campbell Swinton's life-long twin passions of photography and electricity collided with the idea that he is now most remembered for; that of 'distant electric vision', based on the 'vastly superior agency of electrons', as he later put it, or all-electronic cathode ray tube based television.<sup>364</sup> Virtually all of the existing secondary sources date his idea for cathode ray tube-based television as originating in 1908, but a date of 1903/4 is claimed in his autobiography, and in a later paper of his in *Nature* in

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Campbell Swinton became the representative on the Broadcasting board for the Radio Society of Great Britain, successor organisation to the London Wireless Society.

<sup>361</sup> Tait and Walker, *Athenaeum Collection*, 110-111.

<sup>362</sup> Swinton, *Autobiographical and Other Writings*, 52, 60, 100 and 110.

<sup>363</sup> Swinton, "Personal Recollections" Of particular note are the many photographs of the 'notables' taken by Campbell Swinton himself.

<sup>364</sup> Swinton, "Letter to the editor", *The Times*, 1928.

1926.<sup>365</sup> The first definite record is indeed in 1908, with a letter to *Nature* on June 18th, in response to a letter about distant electric vision contributed by physicist and electrician Shelford Bidwell, some of whose work was described in Section 2.4.3. Earlier in 1908, in the June 4<sup>th</sup> issue of *Nature*, Bidwell had proposed a mechanical image scanner and reproducer based on his own still picture scanner of the 1880s.<sup>366</sup> Campbell Swinton, in his June 18<sup>th</sup> response, began by explaining the limitations inherent in any such mechanical device in terms of the speed and image detail that could be sent. He then continued by briefly outlining his own proposals for an alternative method, stating:

The problem of obtaining distant electric vision can probably be solved by the employment of two beams of cathode [cathode] rays (one at the transmitting and one at the receiving station) synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energised by two alternating electric currents of widely different frequencies, so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within the one-tenth of a second necessary to take advantage of visual persistence.<sup>367</sup>

In the closing remarks of his 1908 letter he concluded: ‘It is an idea only ... Furthermore, I do not for a moment suppose that it could be got to work without a great deal of experiment and probably much modification’.<sup>368</sup> He was well placed to comment, as by the early 1900s he had acquired considerable expertise concerning the design and construction of CRTs, impressively harnessing this knowledge to disintegrate diamonds by using high power cathode rays, and ultimately creating

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<sup>365</sup> Swinton, *Autobiographical and Other Writings*.

Swinton, “Electric Television” An acknowledgement is recorded of help received from scientist Prof. G M Minchin (a specialist in light sensitive cells) and his own technical assistant, Mr J C Stanton.

<sup>366</sup> Bidwell, “Telegraphic photography”.

<sup>367</sup> Swinton, “Distant Electric Vision”.

<sup>368</sup> Ibid.

artificial rubies.<sup>369</sup> There were no further exchanges between the two on the subject via the letters column of *Nature*, and the topic was not pursued by others.

No schematics of Campbell Swintons's idea were presented in this first publication, and it was not until the evening of November 7<sup>th</sup> 1911, in his presidential address to the Röntgen Society, that a sketch was shown (reproduced in Figure 4.4). These proposals, and the accompanying sketch revealed in the address, were reported as being startling to those present. Upon opening the discussion, physicist Professor Silvanus Thompson remarked that: 'those drawn elsewhere ... do not know what they have missed'.<sup>370</sup> A major innovation in the detail of the 1911 proposal was the use of a mosaic of isolated rubidium cubes in the pick-up device, breaking up the picture into isolated picture points. Campbell Swinton admitted during the course of the evening that the scheme was in need of much development and modification to make it work, and that he fully appreciated many of the problems. The *Times Engineering Supplement* was greatly impressed and featured a prominent report of the proposals.<sup>371</sup> In 1924, Campbell Swinton updated and expanded his own ideas over three issues of *Wireless World and Radio Review* (a publication with a world-wide readership) in an article called 'The Possibilities of Television with Wire and Wireless', making use of recent developments in electronics, notably CRTs with heated cathodes (yielding thermionic emission), triode valve amplification and circuit techniques for producing specific waveforms.<sup>372</sup>

By the mid-1920s, Campbell-Swinton's later articles, letters, lectures and papers had been disseminated to a wide audience of interested parties around the world. It is likely, if not certain, that the plethora of patents that began to appear in the 1920s regarding all-electronic television owed much to the above mentioned diagram and subsequent adaptations. His work was certainly cited by patent examiners in the late 1920s and early 1930s as being important prior art. Zworykin had major difficulties with his 1923 patent for his iconoscope as a result, with only an American patent

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<sup>369</sup> Swinton, "Vacuum Tube Phenomena".

<sup>370</sup> Bridgewater, *Campbell Swinton*, 22.

<sup>371</sup> "Distant Electric Vision", *Times Engineering Supplement*.

<sup>372</sup> Swinton, "The Possibilities of Television".

ever being granted, and that only after much legal wrangling, in 1938.<sup>373</sup> With regard to patents, the key technical question was whether Campbell Swinton had ever described the concept of storage, which describes the integration of the incident light from a scene onto the pick-up, greatly enhancing the practical sensitivity (see Appendix 4.1). The patents which began to appear in the 1920s, featuring an all-electronic pick-up and display system based on CRTs, varied enormously in quality and scope, but the question of storage and its origins returns frequently in subsequent patent disputes. I will explore these very complex and hard-fought international ‘patent wars’ concerning all-electronic television further in Chapter 5. Notwithstanding disputes over storage, the basic technical architecture of the proposed systems in these patents still echoed the concepts described by Campbell Swinton of using scanned CRTs for both pick-up and display. Throughout the 1920s and early 1930s such proposals became ever more detailed, but still the core ideas of Figure 4.4 can be seen again and again.

An example of such a patent, is one from a Hungarian researcher shown in Figure 4.5, often simply referred to in secondary sources as the ‘Radioskop patent’.<sup>374</sup> This patent, granted in 1926 to the scientist Kalman Tihanyi, is a good example of the embellishments then appearing. As with Zworykin’s, it was almost certainly based on Campbell Swinton’s architecture, but shows many refinements, including electronic amplifiers and scanning circuits. RCA purchased Tihanyi’s patent and also a British patent taken out by Canadian inventor Francois Charles Pierre Henrouteauas, as both had features in common with Zworykin’s tube.<sup>375</sup> As the company’s approach was always ‘The Radio Corporation does not pay royalties, we

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<sup>373</sup> Zworykin, “Television System”, United States Patent Office, 1923. This is the disputed patent which was not granted until Dec 20 1938. For the background to the problems see: Abramson, *Zworykin*, 45 and ref. 14 on 218 explores Zworykin’s difficulties with the Campbell Swinton prior art problem. Abramson suggests that Zworykin must have been influenced by Campbell Swinton’s published work.

<sup>374</sup> UNESCO Memory of the world citation: Kalman Tihanyi’s 1926 Patent Application Radioskop [http://portal.unesco.org/ci/en/ev.phpURL\\_ID=23240&URL\\_DO=DO\\_TOPIC&URL\\_SECTION=201.html](http://portal.unesco.org/ci/en/ev.phpURL_ID=23240&URL_DO=DO_TOPIC&URL_SECTION=201.html) Accessed: 11/18/2010.

<sup>375</sup> Abramson, *Zworykin*, 107. Notes the patent problems reflecting the simultaneous invention of pick-up tubes in the late 1920s and early 1930s.

collect them', to have paid must have meant that both were potent threats to the iconoscope patent.<sup>376</sup> Given Zworykin's on-going difficulties at that time with his own 1923 application, this probably explains why RCA was so keen to purchase already granted patents in case of the failure of their own claims, given the strong prior art of Campbell Swinton, Rosing and the other patents appearing in the late 1920s and early 1930s.

At a first glance, Figure 4.5 does not seem to bear much resemblance to Figure 4.4, but it is describing the same idea, albeit with much improved CRTs and electronic triode valve amplifiers adapted from advances in wireless technology. The pick-up tube is on the top left and the display tube on the top right. Beneath the CRTs appear details of the pick-up target, the display screen and some of the electronics. The patent was further embellished with more detail of the supporting electronics offered and appears later in 1928 as British and French versions. The technical similarity to Campbell Swinton's 1911 proposals, strongly suggest that it is a case of the dissemination of Campbell Swinton's ideas rather than simultaneity of invention.

Campbell Swinton appears to have had no commercial interest in developing television. He never actually patented anything to do with television, yet he was no stranger to the process and the benefits of patenting.<sup>377</sup> Why he did not patent his ideas is unknown. Perhaps he reasoned that he had already effectively disclosed the idea in his 1908 letter, thus barring any subsequent application. His reasons might have been altruistic, or that he thought that his ideas weren't sufficiently well developed, or perhaps he considered the whole notion of 'distant electric vision' not to be sufficiently 'scientific', perhaps too speculative. Evidence for this latter possibility may lie in a reported view attributed to Braun that 'seeing at a distance was not an altogether respectable subject for investigation in those days [early

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<sup>376</sup> This quote is attributed to David Sarnoff, president of RCA. The background is given in Stashower, *Boy Genius and the Mogul*, 243.

<sup>377</sup> Most of Campbell Swinton's British patents relate to telephone related inventions, with some ten patents granted between 1884 and 1891, but beyond that date his applications almost cease. A list of his patents can be found in Bridgewater, *Campbell Swinton*, 34-39.

twentieth century] – it was regarded much as were perpetual motion machines’.<sup>378</sup> Whilst this was probably hyperbole, the concept of a ‘distant vision’ machine was still science fiction in the early 1900s. In his 1924 paper read at a meeting of the Radio Society of Great Britain, and was reported at length over three issues of the journal *Wireless World*, Campbell Swinton is sceptical about the likelihood of rapid progress being made on his ideas.

### **4.3.3 Campbell Swinton’s opposition to electro-mechanical television**

An acid letter written by Campbell Swinton to the *Times* in 1928 contained an angry attack on low-definition electro-mechanical television as championed by John Logie Baird.<sup>379</sup> In a private letter to a friend, BBC Chief Engineer P P Eckersley, Campbell Swinton complains that the *Times* did not publish his letter in full, missing out a part which stated: ‘Baird and Hutchinson are rogues, clever rogues and quite unscrupulous, who are fleecing the ignorant public, and should be shown up’.<sup>380</sup> Apparently, the *Times* felt that this was unsuitable for a ‘gentleman’s newspaper’. There are other examples of his vitriolic criticism of the electro-mechanical systems in surviving letters in the Swinton family archive, with letters to T F Purves, Engineer in Charge of the GPO, scientist Sir Oliver Lodge, and a particularly scathing communication to fellow FRS, physicist James Jeans, in which he states:

No one has always been more ready than I have to assist in the development of new scientific inventions, as nothing gives me greater pleasure; but I have always drawn the line at those who resort to unscrupulous and swindling methods to arrive at the result that they hope for, as I am sure is the case with those associated with Baird and his companies.<sup>381</sup>

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<sup>378</sup> Kurylo and Susskind, *Ferdinand Braun*, 100 and ref. 116 reported that Dieckmann, in his 1958 German language book about Braun, recalled this opinion.

<sup>379</sup> Swinton, “Letter to the editor”, *The Times*, 1928.

<sup>380</sup> Swinton, A. A. C. Letter to P P Eckersley, BBC file T16/42, sub file 1 1928. BBC Written Archives.

<sup>381</sup> Swinton, A. A. C. Letter to J H Jeans, May 16, 1929, Swinton family archive.



Campbell Swinton's final (unpublished) written work on the subject of television was an article intended for publication in the 1930 BBC Yearbook,<sup>382</sup> written in August 1929, about the problems and challenges ahead in the field of television, pointing out his opinion of the inevitability of all-electronic television.<sup>383</sup> It was returned to him that same month, never to be published, with a letter explaining that the BBC was 'to ignore television in the 1930 Yearbook'.<sup>384</sup> In this letter the Corporation agreed that the eventual inevitability of all-electronic television was very much official BBC opinion as well. Notwithstanding this, one month later the BBC started broadcasting using the 30 line electro-mechanical television technology, developed by Baird. The Baird publicity machine had won, at least in the short term, the battle to start a television service, albeit one tagged as 'experimental'. This was against the wishes not only of Campbell Swinton but of the BBC governors, the GPO and other scientists unwilling to voice their concerns in public such as Sir Oliver Lodge, Sir William Bragg, Sir Duguld Clerk and Sir Charles Parsons.<sup>385</sup> Campbell Swinton died in London on February 19<sup>th</sup> 1930 at the age of 66 of pneumonia. He kept returning to the subject of 'distant electric vision' (now habitually using the word 'television') right up until his final months. Baird's electro-mechanical television was the only television that he ever saw, but his opposition to such technology was, in the opinion of Baird's biographers, Malcolm Baird and Anthony Kamm, still being felt two years after his death with the black-balling at the Athenaeum Club of Major A G Church, a Baird Company director.<sup>386</sup>

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<sup>382</sup> Swinton, "Television: Past, Present and Future", 1929, unpublished, Swinton family archive.

<sup>383</sup> The BBC Yearbook is an annual review of the activities and future aspirations of the Corporation. It contains financial data along with details of past programmes, engineering work and plans for future services and programmes.

<sup>384</sup> Bridgewater, *Campbell Swinton*, 31. Describes the return of the article and the draft article, annotated as 'returned' exists in the Swinton family archive and is dated Aug 31 1929.

<sup>385</sup> Campbell Swinton cites the support of these scientists in a letter to Sir J H Jeans, objecting to Baird demonstrating his equipment at the Royal Society. Letter from A A Campbell Swinton to J H Jeans, May 16 1929, Swinton family archive.

<sup>386</sup> Kamm and Baird, *John Logie Baird*, 274-275. The authors cite the records of the Athenaeum Club in defence of this view.

Campbell Swinton's proposals were comprehensive and elegant in the use of CRTs for both pick-up and display, but the contemporary (and probably unconnected) suggestions by Rosing also had their own profound effects upon the development of all-electronic television via the efforts of his student, Zworykin. I will now describe Rosing's work, and how the subsequent developments by others within his circle, developed in parallel with Campbell Swinton's suggestions for a CRT based television system.

#### **4.4 Rosing and his compatriots**

Virtually all of the Western secondary sources treat the Rosing narrative as a minor adjunct to that of his much better known student, Zworykin. This is understandable, as in the 1930s Zworykin became the leading technical actor in the development of all-electronic television following his early education under Rosing and his emigration to the United States in 1919, as he eventually assumed leadership of the RCA television development programme. Rosing's ideas were developed at about the same time as Campbell Swinton's, but the circumstances of his work in post-Revolutionary Russia were far from ideal. As a supporter of the White Russians, Rosing's position in society following the Revolution was very much diminished, and continuing his own work on all-electronic television was difficult.

##### **4.4.1 Rosing's background and early work**

Born in 1869 in St Petersburg, Russia, into a minor aristocratic family, Rosing received a *gymnasium* education before going up to the faculty of physics and mathematics at St Petersburg University in 1887.<sup>387</sup> Graduating in 1891, he went on to further study and research before defending his dissertation for a candidate's degree, which, in pre-revolutionary Russia, was roughly equivalent to a doctorate. In 1893, he joined the Technological Institute in St Petersburg as a member of staff, initially working on magnetism and by 1897 he was director of the physics department. It is likely that Rosing knew about early Russian proposals for the idea of television made in the late nineteenth century by researchers and inventors,

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<sup>387</sup> A gymnasium education in Russia at that time was at secondary level over an 8 year period and prepared students for university entry.

especially those by fellow countrymen, M Vol'fke, P I Bakmet'yev and A A Polumordinov, but none of these ideas involved CRTs.<sup>388</sup> The accounts of his work in the secondary literature then jump straight to his patented proposals for using CRTs for 'electrical telescopy', but there is no explanation of how and why.

His British patent of 1907 for 'Electrical Telescopy' describes a system of distant electric vision; although in this he concentrates mainly on the receiving display side.<sup>389</sup> In the preamble to the patent he states:

Known methods of so called electrical telescopy whereby light pictures of visible objects located at a distance from the position of view or receiving station are unsatisfactory; on account of the relatively sluggish action of the apparatus employed at the receiving station to produce the pictures.<sup>390</sup>

This reference to the existing electro-mechanical proposals implies that his method using a CRT for the display would be considerably faster in terms of its operation (neglecting the corresponding speed problems of the pick-up device as appreciated by Campbell Swinton who was proposing CRTs for display and pick-up), because the patent application depicts a CRT based display with an electro-mechanical pick-up. Besides his British patent, Rosing also acquired patents for his ideas in Germany and in the United States. This would have been a fairly expensive process, especially so in Germany, which suggests that Rosing had some financial backing and/or considerable belief in the potential commercial prospects for his invention.

No known communication exists between the two proponents of the use of CRTs for distant vision. Campbell Swinton makes no reference in any of his writings of the December 1907 Rosing patent application, which is likely to be because the patent was not actually granted until December 1908, after his letter to *Nature* had been

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<sup>388</sup> Uralov, *Essays on the History of Television*. See 53-54 for Vol'fke's proposals, 50-51 for those of Bakmet'yev, and 59-64 for those of Polumordinov.

<sup>389</sup> Rosing appears to have preferred the term 'Electrical Telescopy' to describe the process of remote viewing, both for transmitting and receiving.

<sup>390</sup> Rosing, "New or Improved Method of Electrically Transmitting to a Distance Real Optical Images and Apparatus therefor", Patent No. 27,570.

published in the June of the same year. Likewise, in the available literature and records in Russia, none of the very limited primary sources known mentions any communication or contemporary acknowledgement of Campbell Swinton's ideas. The possibility of communication between Rosing and Campbell Swinton exists, but the only evidence that I have found is weak, concerning a relative of Campbell Swinton's who was fluent in Russian. Sir John Swinton, the current Swinton family archivist, is of the opinion that no communication between the two took place.<sup>391</sup>

The main drawing in the patent is reproduced in Figure 4.6, which shows the electro-mechanical pick-up to be based on a two axis rotating polygon drum scanner directed to a photocell. The CRT display was synchronised in its scanning to the polygon drums. Given the then virtually non-existent methods to amplify the signals from the pick-up and the 'hard' CRTs of the time, Rosing found it difficult to make his idea work. By 1911 he had achieved working results of a kind, and his apparatus was the most successful television hardware yet created anywhere in the world. Rosing managed to display a simple four-line picture (or, more accurately, a four-band system as the lines were very broad). A surviving laboratory notebook entry records that: 'On 9 May 1911, a distinct image was seen for the first time, consisting of four luminous bands'.<sup>392</sup> This would have almost certainly been a silhouette, as the inherent insensitivity of the system would have precluded an image produced by reflected illumination. Very brief reports did appear in the West and further patents from this time are also known, but there is no detail.<sup>393</sup> It is possible, given some of the technical similarities, that Rosing had been influenced by the work of Dieckmann and Glage, especially their patent of 1906. Rosing almost certainly knew of their work, because in his 1907 patent he references two other earlier German patents

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<sup>391</sup> Correspondence between myself and Sir John Swinton, September 2006.

<sup>392</sup> This reference is quoted in several books with the original source cited as being Notebook 3, 1911, Archives of the A S Popov Central Museum of Communication (St Petersburg). I have not personally verified this.

<sup>393</sup> Rosing, "Improvements relating to the transmission of light pictures in electrical telescopic and similar apparatus", Patent No. 5486.

concerning CRTs. This possibility was denied many years later in the 1930s by his former pupil, Zworykin.<sup>394</sup>

Post 1912, the record of Rosing's personal work in electrical telescoping is largely lost. The sequence of the Great War, the Russian Revolution and then the Russian Civil War of 1922 would likely have made meaningful work difficult, especially as a White Russian who opposed the new government. In the early 1920s, Rosing moved to Krasnodar in the far south of the country, becoming a co-founder of the Kuban State Technological University. During this time he did manage to publish a book on electrical telescoping, but there is no known copy of this surviving in the West.<sup>395</sup> Ultimately, Rosing's political views eventually resulted in his being sent to a forest gulag near Arkhangelsk in 1931 as a dissident intellectual in one of Stalin's purges. Sentenced to three years at a forestry institute, he was released early, but died in exile in Archangel in 1933 of a brain haemorrhage. By that date, his former student Zworykin was leading all-electronic television development for RCA in the United States, and it his work which I will examine next.

#### **4.4.2 Zworykin the student**

Born in Murom in 1889 in Tsarist Russia, one of seven surviving children of a fairly wealthy merchant, Zworykin was the one favoured by his father to take over the family business. Graduating with honours from the realschule in Murom he decided to try for a career in engineering, but probably without much enthusiasm and mainly on the strength of family connections in professional engineering.<sup>396</sup> At his second attempt, he was accepted into the physics department of the St Petersburg Technological Institute. It was there where he first met Rosing, the director of the physics department, who invited him to help with his experiments in electrical telescoping. Zworykin was set to work on Rosing's experimental cathode ray tubes

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<sup>394</sup> Zworykin, V. Z., tape-recorded interview with G R M Garratt (Deputy Keeper Communications Section, London Science Museum) May 3, 1965.

<sup>395</sup> Rosing, *Electrical Telescope*.

<sup>396</sup> A realschule in Russia was equivalent to a high school, a rather more practical education than the academic gymnasium. The Tsarist bureaucracy of the time and the academic intelligentsia wanted Russian education to be modelled on the German practice.

and for two years from 1910 to 1912, whilst still a student, he helped Rosing develop his apparatus. A lot of this involved mundane operation of the actual laboratory equipment, such as creating vacuums in the CRTs with ineffective vacuum pumps requiring endless lifting of weights. However, Zworykin did experience at first-hand what was needed to make and operate the hard CRTs, including the problems of glass blowing, glass-metal seals and vacuum techniques.

Following his graduation in 1912, Zworykin spent time in Paris under physicist Paul Langevin at the Collège de France, working mainly on crystal X-ray diffraction. This was a field about which he knew nothing, but he had some success in creating the equipment to perform the experiments.<sup>397</sup> Soon after his time in Paris he was caught up in the maelstrom of the Great War. Zworykin entered the Imperial Russian Army as an engineer private specialising in radio communications, rising to the rank of lieutenant and working on radio equipment and ciphers. He was eventually posted to the Russian Wireless Telegraph and Telephone Company (the Russian arm of MWTCO.) in Petrograd as an inspector in 1916. Discussions turned towards television, and an offer for him to form a television research group once the war was over was made by the technical manager of the factory, Dr Serge M Aisenstein.<sup>398</sup> Following the Revolution, Zworykin appears to have acquiesced, at least initially, to the new regime, and in turn was trusted by the authorities.

#### **4.4.3 Zworykin the émigré engineer**

The narrative of this stage of Zworykin's career begins with his first visit to the United States in late 1918 as an engineer collecting parts for radio equipment for use in Siberia under the direction of the Soviets. He returned home as scheduled, but was then asked to go back to the United States by the Russian Ministry of Transportation on a similar mission in 1919. Once there, he made the decision to stay, which meant leaving his wife behind, not even knowing where she was, given the turmoil in Russia. Desperate for work, he accepted a job at the Russian Embassy (the revolutionary government was still not recognised by the embassy at that time). This gave him time to learn something of the English language and determine the

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<sup>397</sup> Zworykin and Olessi, "Iconoscope", Chapter 2.

<sup>398</sup> Abramson, *Zworykin*, 22-23.

whereabouts of his wife, who turned out to be in Berlin. Seeking a job in engineering, he eventually succeeded in securing a post with Westinghouse Electric in 1920 at half of the salary that he had been receiving from the Russian Embassy.

The Westinghouse patent department manager, Otto Sorge Schairer, was impressed with the young émigré's knowledge and inventiveness, but the pay was simply not enough to support his recently arrived wife and first child. After being turned down for a pay rise, Zworykin accepted a higher paid job with an oil company which did not last, and he returned to Westinghouse in 1923 under a new management, who, according to an apocryphal story, indulged their able Russian engineer by asking him what he would like to work on. His answer was – according to his autobiography – CRT television.<sup>399</sup> Zworykin returned to Westinghouse with a higher salary, a contract for several years and a great deal of goodwill. The company's managers recognised the inventive ability of their engineer and did give him free rein, at least for a while. The result was Zworykin's first patent application for an all-electronic CRT based television system with the pick-up based on the principle of photoemission.<sup>400</sup> It wasn't the first patent application based solely on CRTs: French inventor Edvard-Gustav Schoultz's patent of 1921 featured an electro-magnetically deflected CRT exploring a photocell array in a spiral pattern, and Russian scientist Boris Rtcheouloff's patent of 1922 was based on a photo-element in a vacuum tube scanned electro-mechanically.<sup>401</sup> Rtcheouloff also described a receiving tube, replacing the photo-element with a fluorescent point source of light. These patents first appeared first in the USSR, then in Britain (1926) and finally in the United States (1927), so it is likely that the Westinghouse patent library would have had sight of one or more versions of it.<sup>402</sup> Whether these proposals were examples of simultaneous invention or logical developments of Campbell Swinton's ideas is debateable. As for influences on Zworykin, Abramson is of the opinion, although

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<sup>399</sup> Ibid., 44.

<sup>400</sup> Zworykin, "Television System", Patent No. 2,141,059.

<sup>401</sup> Schoultz, "Procédé et appareillage pour la transmission des images mobiles à distance", Patent No. 539,613; Rtcheouloff, "Television and Telephotography", Patent No. 3803.

<sup>402</sup> Rtcheouloff, "Improvements in and relating to Television and Telephotography", Patent No. 287,643; Rtcheouloff, "Television and Telephotography", Patent No. 1,745,029.

offers no corroborating evidence, that he was well aware of the Campbell Swinton ideas and proposals, stating that:

Zworykin certainly learned of the Campbell Swinton articles from the Westinghouse patent library, and he was able to use it to persuade Westinghouse to reduce his patent application to practice as soon as possible.<sup>403</sup>

Zworykin's patent was for a complete system of pick-up, transmitter, receiver and display, whereas the earlier French patent was just for the pick-up tube, and the Russian one a hybrid electronic/electro-mechanical device. In terms of the adoption of CRTs, both patents were similar to Campbell Swinton's concept. The scanning methods proposed were different, but neither patent mentions or implies light integration – the storage principle. Another late 1920s patent did describe the storage concept, although its application was picture telegraphy pick-up, and so not directly related to television, but still citable as prior art. This patent, in the name of Marconi engineer Captain H J Round, was applied for in 1927, granted in 1930 and assigned to MWTC Co. Ltd. and become another problem for RCA in its quest to secure patent coverage for Zworykin's work.<sup>404</sup>

By 1924, Zworykin had become a naturalised citizen of the United States and had enrolled in the physics department of the University of Pittsburgh for a two-year PhD (one year of credit was given for his time at the College de France under Prof. Langevin). Also in 1924, he began reducing his own television patent to practice, but with little success. From 1925 Westinghouse senior management decided that Zworykin should be working on something more immediately useful: photocells for their cinema sound systems, otherwise known as the 'talkies'. This occupied most of his time in the last years of the 1920s, but the knowledge that he gained working on photocells was very useful research towards developing his ideas for all-electronic television. In his own time, Zworykin was still working on television, and further patent applications were made by him throughout this period. Competition began to

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<sup>403</sup> Abramson, *Zworykin*, 49.

<sup>404</sup> Round, "Picture Telegraphy", Patent No. 1,759,594.



emerge; other system level patents were also appearing, notably one by engineer H J McCreary of the Associated Electric Laboratories Inc., which also used CRTs for both pick-up and display, although he additionally envisaged colour, with three optically combined/split red, green and blue channels.<sup>405</sup> By 1926 Zworykin had his doctorate. His thesis, entitled ‘Study of Photoelectric Cells and their Improvement’, related to his work for Westinghouse on photocells. His television work progressed only in the background, and mainly only on the display CRT or kinescope, as he usually described it.<sup>406</sup>

Commercial reorganisation and realignment in the American wireless and nascent electronics industries in 1929 led to Zworykin being transferred from Westinghouse Electric’s East Pittsburgh laboratories to the new RCA Victor plant in Camden, New Jersey. With the rising corporate star David Sarnoff as the new president of RCA there were changes, new ideas, and fresh projects being pursued by the company. Sarnoff (another émigré Russian, albeit one who had emigrated as a child), recognised Zworykin’s ideas on kinescopes and pick-up tubes as having potential for a much better television system than the electro-mechanical systems he had already seen. This suited RCA’s long-term technical aspirations and plans to develop new consumer electronics technologies such as television during the Great Depression, to be ready in time for the expected economic recovery. Part of the apocryphal story of television development, according to post war RCA publicity, has Zworykin and Sarnoff meeting in 1929 to discuss the prospects for the technology. Sarnoff later recalled that Zworykin said that RCA would ‘be able to complete the development in about two years and estimated that this additional help would cost about a hundred thousand dollars’.<sup>407</sup> The conclusion to this story is that Sarnoff later relates that

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<sup>405</sup> McCreary, “Television”, Patent No. 2,013,162. This patent was applied for in 1924, but not granted until 1935 following disputes over Zworykin’s patent, contested by RCA.

<sup>406</sup> Zworykin, in common with a number of wireless and electrical engineers at the time (and later generations) revelled in creating Latin/Greek names for their inventions. Hence, kinescope from the Greek kinetic, meaning of or related to motion, and scope, as in to see, such as in an observational instrument.

<sup>407</sup> Abramson, *Zworykin*, 76-77 describes the common story about the \$100,000; Bitting, “Creating and Industry - A case Study in the Management of Television Innovation”, 54. Recalls the same story in a personal interview with Zworykin in 1963.

RCA had to spend many millions of dollars to perfect all-electronic television.<sup>408</sup> The estimates offered by Zworykin proved to be wildly optimistic, with the final cost being nearer \$50 million and taking many more years.<sup>409</sup>

With Sarnoff's backing, Zworykin, and his engineering manager, Elmer Engstrom, were able to build their team of researchers and begin work on the project. Progress was rapid, both with regard to the display CRTs (the kinescope) and also with the photoemissive pick-up tube. The prototype pick-up tubes were very inefficient, being based on Zworykin's patent application in being double sided and having the optical image formed on one side of the photocathode, the scanning electron beam then 'reading' the charge information from the other side. In May 1931 Zworykin turned to an alternative scheme: a single-sided design with an angled, offset electron gun, as per a British patent by inventors George J Blake and Henry D Spooner of 1925, and another by Italian inventor Riccardo Bruni, granted in 1930.<sup>410</sup> Although this created further patent problems for RCA, the single-sided tube became the standard approach for such pick-up devices as it was simpler to make and more efficient in its opto-electrical sensitivity. Another classically derived name, iconoscope, was coined by Zworykin for his pick-up device in 1931.<sup>411</sup> The device was essentially an array of photocells addressed sequentially by the scanning electron beam – just as Campbell Swinton had envisaged in 1911, except that the photocells comprising the photocathode were potassium hydride, not rubidium. Zworykin's group achieved a major success with the iconoscope by late 1931 having accidentally solved one of the major problems with the design, the creation of isolated picture elements on the tube's light sensitive photocathode, avoiding a difficult 'ruling' process which

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<sup>408</sup> Burns, *Television*, 388-389.

<sup>409</sup> The reputed \$50 million final cost of RCA's television development cost is revealed in a filmed interview between Zworykin and Sarnoff. The pair recalled the early days of all-electronic television development and Sarnoff ruefully reminds Zworykin of his estimates and the final figure. See: *The Story of Television*, United States: RCA, 1956.

<sup>410</sup> Abramson, *Zworykin*, 107. Describes the move to single sided scanning. The single sided patents are: Blake and Spooner, "Improvements in or Relating to Apparatus for Television", Patent No. 234,882; Bruni, Television Apparatus, Patent No. 310,424.

<sup>411</sup> 'Iconoscope' was derived from the Greek icon (image) and scope (to see) – resulting in 'image seer'.

manually produced tiny square picture elements.<sup>412</sup> The ‘accident’ was leaving one of the prototype mosaics in a processing oven for too long, leading to the formation of very tiny, electrically isolated globules – exactly what they had been trying to achieve by other, more difficult, methods. A patent application followed in February 1932, but was not finally granted until 1936.<sup>413</sup> RCA’s work was finally released to the public in 1933, creating headline news (see Figure 4.7) and a detailed descriptive paper written by Zworykin (see Figures 4.8 and 4.9), published in many journals.<sup>414</sup> This was the practical beginning of a new technology, but it was being demonstrated during the Great Depression, with little prospect of any profitable activity. RCA was not alone in looking for an all-electronic solution – there were rivals: Farnsworth with his image dissector and a team in the USSR, whose work I will examine next.

#### **4.4.4 The ‘Enthusiasts from Tashkent’**

‘Enthusiasts from Tashkent’ is the curious collective title used, in Russian, to describe this group of electronic television researchers.<sup>415</sup> They are virtually unknown in existing Western literature covering the history of early television, but in Soviet and Russian work they figure strongly. The sole account of ‘the Enthusiasts’ work in English is a brief 1980s article by Russian journalist Boris Alexeyev.<sup>416</sup> The only detailed accounts are by Russian historian V A Uralov and an extensive website compiled by Ukrainian radio amateur, R Jury. The following narrative has primarily been pieced together from a translated version of Uralov’s work, translated patents and an extensive Russian language paper in an amateur radio magazine.<sup>417</sup>

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<sup>412</sup> Abramson, *Zworykin*, 106 describes RCA’s technician Sanford Essig’s accidental discovery of a process producing neat, tiny globular pixels of photosensitive material after leaving a sample baking in an oven for too long.

<sup>413</sup> Essig, “Electrode Structure”, United States Patent Office, No. 2,065,570, 1932

<sup>414</sup> Zworykin, “The Iconoscope”.

<sup>415</sup> Uralov, *Essays on the History of Television*, 98-105 and 214. Suggests a translation as ‘Enthusiast[s] from Tashkent’.

<sup>416</sup> Alexeyev, “All-Electronic TV was Tested Here in 1928”, 15-16.

<sup>417</sup> Uralov, *Essays on the History of Television*, 98-105. Translated by Prof M G Tomilin. Further sources are from: Jury, “Boris Pavlovich Grabovsky”, translated in part by N Pannel.

Their story is important in that it brings into question some of the internalist claims about the contemporary Western technology offering only one direction and one solution to the problem of a CRT based pick-up. This in turn confirms that there was a choice in how all-electronic television might develop in the early 1930s. The Enthusiasts' pick-up tube appears to have been based upon a photoconductive technique, using a non-pixelated (continuous) photocathode rather than the pixelated photoemissive type as embodied in the Zworykin approach. Furthermore, it was double-sided, similar to Zworykin's earliest attempts and closely resembling the Campbell Swinton pick-up tube concept. The pick-up device was thus very different from Zworykin's ultimate design, and in this case Rosing had a more direct part to play in the development.

By the early 1920s, Rosing was beginning to suffer under the new Soviet regime, finding that his position in the university was being undermined and the direction of his work controlled. Apart from Zworykin, by then in the United States, there were others still in the USSR who sought to develop his ideas. It is likely that these developments were going on without the knowledge of Western scientists, engineers and inventors, and by the time Zworykin had made his first return visit to his former homeland in September 1934, which included tours of Soviet television laboratories, the team had been disbanded.<sup>418</sup> Before this visit, few, if any, Western scientists would have known that there was a possible Soviet alternative technology (the non-pixelated photoconductive approach) in existence. No mention is made of this work by Zworykin in his unpublished autobiography, despite his recording in some detail visits to the Soviet Union on behalf of RCA (and indirectly on behalf of the American government) in the mid-1930s. Although these visits took place after Rosing's death, and sometime after the disbandment of the 'Enthusiasts', he delivered a number of lectures on television research to Soviet experts in the field. Whether he was informed about the work of the team is not known, but it is likely.

The most significant, and likely leader, of the 'Enthusiasts' was Boris Grabovsky, born in 1901, the son of a nationally famous Ukrainian poet, Pavel Arsen'evich

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<sup>418</sup> Zworykin and Olessi, "Iconoscope", Chapter 7 - Return to Russia 1934.

Grabovsky. By the early 1920s he was a laboratory assistant at the Central Asian University in Tashkent, Uzbekistan (then part of the USSR). Grabovsky's television work began with the invention of a device called a cathode commutator: this appears to have been a proposal to replace a mechanically driven commutator (a multi-way switch) sampling the output of an array of photocells using a deflected cathode ray. The initial application was unrelated to television.

Accounts suggest that having read Rosing's book, *Electrical Telescopy*, Grabovsky became interested in the idea of television.<sup>419</sup> Like Campbell Swinton, he wanted to create a completely all-electronic system with no moving mechanical parts whatsoever. Whether he had access to any of Campbell Swinton's papers or letters, such as those to *Nature*, is not known, but he was proposing the same concept of using a CRT as a pick-up as well as a display. In order to further his education to enable him to develop his ideas, Grabovsky moved to the then newly founded Saratov University in southern Russia, meeting up with a physics tutor, N G Piskunov and an engineer, V I Popov. The three began to take the idea of developing all-electronic television seriously, and by 1925 appear to have had some kind of hardware operating that was named 'radio-telefot' by Grabovsky.<sup>420</sup> Later in 1925 they received funding from the city of Saratov authorities to go to Leningrad and Moscow to canvass for further support. A patent was drawn up and examined by a military-technical session of the Russian Army in the presence of Rosing, the Soviet radio expert M V Shuleikin and other specialists. The result of the examination was positive, and the team was invited to produce prototypes in a very short time-frame of three months. Grabovsky and Piskunov worked with Rosing in Leningrad (having returned from Krasnodar) on the actual CRTs. Popov returned to Saratov.

Progress was slow, largely due to obstructions placed in the Enthusiasts way by the manufacturing plants and by the demands for papers and reports. Even a direct order

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<sup>419</sup> Grabovsky, [http://www.qrz.ru/articles/photos/story450/autobio\\_grabovski.djvu](http://www.qrz.ru/articles/photos/story450/autobio_grabovski.djvu) Accessed: 12/07/2010. This is Grabovsky's autobiography, written in 1964 shortly before his death in 1966. The provenance of the work is not known.

<sup>420</sup> 'Telefot' was not an original name coined by the Grabovsky – it had been used by Russian inventor A A Polumordvinov in the late nineteenth century.

by Premier Felix E Dzerjinsky to expedite production of the prototypes failed to result in much improvement. Exactly what the Soviet government and military were expecting or wanted from the work is not known. Given the very tight time scales, the programme soon reached the end date with only partial results. Returning to Tashkent, Grabovsky met up with a young ‘specialist’ called Ivan Filippovich Belyansky who championed the plight of the team to the Chairman of the Central Support Committee of Uzbekistan, Yuri Ahunbabaev.<sup>421</sup> This resulted in further funding for prototypes and a return to Leningrad for Grabovsky accompanied by Belyansky. Work now progressed with additional support from more technical specialists in Leningrad.

By the winter of 1928, the Radio-telephot had progressed to be able to send silhouettes from one room to another. A few months later it was ready for demonstration in Tashkent on June 26<sup>th</sup> at the communications testing station near the Pakhtakor subway station.<sup>422</sup> In 1965, 3 months before his death, Grabovsky stated:

We managed to show a moving streetcar there. True, that streetcar was in bright sunlight, and the picture was quite bad because of that. We later transmitted a silent picture of two people. The idea of making talking pictures had not yet occurred to anyone. The first man in the world to appear on television was Ivan Belyansky, who took off and put on his cap. The second was my wife Lydia, who moved her lips and made believe that she was engaged in lively conversation.<sup>423</sup>

The above description is simplistic and was written much later, probably with Soviet propaganda in mind. However, the patent, other corroborating written materials and

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<sup>421</sup> A common and baffling reference used by Russians to this day is the term ‘specialist’ which can mean a variety of roles, not necessarily technical.

<sup>422</sup> The demonstrations are documented in the St Petersburg Museum of Communications and until recently in a dedicated museum in Tashkent which is now closed.

<sup>423</sup> Alexeyev, “All-Electronic TV was Tested Here in 1928”, 18. This Grabovsky quotation appears in various articles in slightly different forms, but the essentials remain the same. The quotation is said to come from a newsreel report about Grabovsky recorded in 1965.

photographic evidence in a former Soviet archive in Moscow survive.<sup>424</sup> My analysis of the translated patents suggest that the techniques appear to have been plausible, with further development, albeit with a very limited performance, especially in terms of sensitivity and image resolution. Pick-up tubes based on the photoconductive approach were entirely practical, becoming commonplace after World War II, but whether Grabovsky and his team had begun to explore the technology remains speculative.

Figure 4.10 shows the schematic of the 1926 Grabovsky patent for an all-electronic television system. The top of the diagram presents the transmitter and pick-up CRT, the bottom, the receiver and display CRT. The supporting translated text does not help to confirm or deny the viability of the patent, but it is similar in detail to the Tihanyi patent and again suggests the fundamental ideas of Campbell Swinton, although this example appears to propose the use of photoconductive technology for the pick-up. There would need to be evidence of saw-tooth scanning and more amplification in the video amplification stages if this was to be close to practical realisation, but with the state of electronics at that time, even in the Soviet Union, I believe that it is possible that it could have been made to work in a very limited manner. Intrinsically, the tube would have the storage characteristic, but depending upon the materials used, it is likely that the tube would have been very insensitive. The translated patent is quite vague in its technical descriptions, especially with regard to the operating principles of the pick-up tube itself.<sup>425</sup> Even if it had been technically important, the patent posed no threat to Western work on all-electronic television, as Soviet patents were not recognised in the 1920s and 1930s by the United States or by European countries. It is likely that Western companies knew nothing of the existence of the Soviet patent. Why the ‘Enthusiasts’ sought to take out an almost worthless Soviet patent is not known, but the usual reason for an

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<sup>424</sup> Popov, Grabovsky, and Piskunov, “Apparatus for Electrical Telescopy”, Patent No. 4899; Tsentral'nyi arkhiv goroda Moskv (TsAGM)[Central Archive of the City of Moscow], location: P-2562, on. 3, 80, l 28-29, contains photographs and documentation relating to the Telephot from 1928-9

<sup>425</sup> Popov, Grabovsky, and Piskunov, “Apparatus for Electrical Telescopy”, Patent No. 4899. The patent was applied for on Nov 9, 1925, published on Jun 30, 1928 and was valid for 15 years.

Translated by Leonid N Soms, Institute for Laser Physics, St. Petersburg, Russia.

inventor in the Soviet Union to patent an idea was to help secure support from the government and hopefully, if successful, a few privileges in terms of housing provision, travel and conditions of work.

By 1930 the work of the ‘Enthusiasts’ was once again failing to progress, owing, according to one writer, to ‘interference’ by the People’s Commissariat of Internal Affairs.<sup>426</sup> The team was broken up: Grabovsky was sent to Sochi in the Crimea, Belyansky to Saratov, while Popov and Piskunov returned to teaching. They and the rest of the team never worked on television again and barely escaped being brought to trial. Uncertainty surrounds the reasons for abandonment of the work, and there were accusations made by Grabovsky in the 1960s about the American author/physicist and Soviet sympathiser Mitchell Wilson allegedly passing on the details of his invention to American companies.<sup>427</sup> In his novel, *My Brother, My Enemy* (which was also published in Russian in the USSR), Wilson describes much of the Grabovsky narrative and technical detail.<sup>428</sup> Whilst the accusation is unlikely to be true, there are many similarities in the novel and the technicalities are quite precise, as would be expected from a physicist turned author such as Wilson. Whilst the story of the Enthusiasts remains vague and difficult to fully substantiate, it does illustrate that all-electronic television was being independently developed in the USSR in parallel with British and American activities.

#### **4.5 Rival ideas from Utah, United States**

Contemporary to the ‘Enthusiasts’ work, another small team, in the United States, the Farnsworth Television Laboratories Inc., was also attempting to invent all-electronic television, also with no reference to Zworykin and RCA, but probably influenced by Campbell Swinton and Bidwell. The ideas from Campbell Swinton in Britain and from Rosing/Grabovsky in Russia are fairly closely linked, despite the fact that the fundamental operating principle of the pick-up tubes are different, being respectively photoemissive and photoconductive. A CRT-based pick-up can be made with either technology and both will exhibit storage, but in the early 1930s onwards

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<sup>426</sup> Balashkin, “Discovery. Do you know that?”.

<sup>427</sup> Jury, “Boris Pavlovich Grabovsky”.

<sup>428</sup> Wilson, *My Brother, My Enemy*.



it was the photoemissive RCA iconoscope which dominated, for this had shown the most promise, at least in the West. The receiver display CRT was an easier conceptual proposition, and developments in the Soviet Union, Britain, Germany, France and the United States were at a similar level, with information and techniques flowing fairly freely between individuals and companies and across national boundaries, despite commercial rivalry and competition. One possible reason for this is the central position held by RCA in terms of patents and agreements with many of the major international companies, and also their poaching of individual researchers such as Russian physicist Gregory N Ogloblinsky (then working in France) who joined the company in July 1929. This followed after a European fact finding tour by Zworykin in late 1928, in which he visited companies involved in television research in Britain, Germany and France.<sup>429</sup> In 1929, the RCA pick-up technology was still proving very difficult to develop, and there was a rival American technology making better progress.

A Utah farm boy, Philo Taylor Farnsworth, had very different ideas about how to make an all-electronic pick-up, and strictly speaking, it was not a CRT. It did, though, share most of the practical glassware construction methods associated with other electron tubes, and it did use the technology of photoemission and electrical scanning. His invention, the image dissector, did eventually work, although not very well as it suffered from gross insensitivity, primarily because it did not possess the storage principle. Farnsworth found himself having to counter not only the practical and theoretical problems of his invention, but also the commercial power of RCA. His story describes an American dream of a hard working rural boy making good in the world of invention, technology and commerce, and this is perhaps why the narrative remains a popular subject for biography in the United States. His story appeals to the American patriot as being rather like those of Thomas Edison, Orville and Wilbur Wright or Nikola Tesla: an independent 'lone inventor' (although actually supported by a small team, as would be expected), creating a new technology. In *American Genesis*, Thomas Hughes noted that the Great War effectively removed the independents as the pre-eminent source of invention and

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<sup>429</sup> Abramson, *Zworykin*, 79.

development. Farnsworth's story provides a counter-example, although the large corporations eventually prevailed.<sup>430</sup>

Farnsworth was born into a Mormon farming family in Utah in 1906, and in the main followed the typical life of such a background: hard work alternating between farm, school and church. The established narrative continues with Farnsworth's family moving to Rigby in Idaho in 1918, where he attended high school, and at the age of 15 impressing his chemistry teacher, Justin Tolman, with his enthusiasm and depth of questions. At home he was an enthusiastic amateur engineer mending electrical generators and motors, and an avid reader of titles such as Gernsback's *The Electrical Experimenter*, which from time to time featured articles on the current ideas for television and predictions about what it might involve, as I described in Chapter 3. Inspired by the idea of television, Farnsworth read everything that he could find on the topic, including Campbell Swinton's ideas carried in *The Electrical Experimenter*.<sup>431</sup>

The romantic image is projected of a boy ploughing his father's fields, methodically mapping out the field furrow by furrow and being struck with the notion of scanning; an image that is strongly associated with Farnsworth, 'the boy genius', as he has become known in several biographies.<sup>432</sup> The concept of scanning had, of course, been around for a much longer time as, as I described in Chapter 2, but Farnsworth's all-electronic television system, which occurred to him at the age of 15, was newer. At school, he described his ideas in detail to his chemistry master, Tolman, and there is evidence to support this claim in the form of later statements in patent hearings and in a surviving drawing (see Figure 4.12).<sup>433</sup> In essence what he described was not of great novelty as a display, simply using the ideas of Campbell Swinton and Rosing, but the pick-up appeared to be ingenious. His idea was similar to that of Bidwell, as published in the letter to *Nature* of 1908, which prompted Campbell

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<sup>430</sup> Hughes, *American Genesis*, 138-139.

<sup>431</sup> Secor, "Television", 132.

<sup>432</sup> Stashower, *Boy Genius and the Mogul*; Godfrey, *Philo T Farnsworth*; Schwartz, *Last Lone Inventor*.

<sup>433</sup> Arnold, "His Vision Made Television", 76.

Swinton's initial public disclosure of his own concepts.<sup>434</sup> There is no proof that Farnsworth was influenced by Bidwell's mechanically based scheme, but his scanning method is a direct electrical analogue of the earlier mechanical idea. In that scheme, it was the mechanical nature of the assembly that Campbell Swinton found improbable, not the actual scanning concept employed.

Farnsworth's method used electromagnetic fields instead of mechanical motion to produce the scanning action (see Figure 4.12) and did not suffer from the speed limitations of Bidwell's method. The scheme relied on exposing a light sensitive electrode (a photocathode) to an optical image plane of the scene to be televised, which created an electron image proportional in intensity to the scene illumination. By sweeping the electron image across a pinhole in a regular manner (raster scanning), and then collecting the electrons passing through it, a sequential electrical representation of the scene was created.<sup>435</sup> In Bidwell's proposal, the pinhole was for light to pass through, and was moved physically by mechanical methods, whereas in Farnsworth's device the image was an electron image scanned across the pinhole by electromagnetic methods. Cathode rays were not used, just the electrons emitted by the photoemissive target (photocathode), and as only an instantaneous electrical signal was presented to the aperture (pinhole), there was no storage, and the sensitivity was very, very low. Independently, two German researchers had also invented much the same idea, but they never managed to reduce the theory to practice, unlike Farnsworth who eventually succeeded, christening his device the image dissector.<sup>436</sup>

Farnsworth was able to assemble a small team, comprising his fiancé, Elma (Pem) Gardner and future brother-in-law Cliff Gardner, financed by a Salt Lake City Community Chest scheme led by San Francisco philanthropists Leslie Gorrell and

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<sup>434</sup> Bidwell, "Telegraphic photography".

<sup>435</sup> The term raster is derived from the Latin word *rostrum*, meaning rake, and is thus analogous to raking soil in parallel lines.

<sup>436</sup> German scientists Dr M Dieckmann and Dipl Ing R Hell patented a similar device to the image dissector but some eight months after Farnsworth's patent of January 1927. They never managed to make it work.

George Everson.<sup>437</sup> With the limited funding secured, he was able set up a small laboratory in Green Street San Francisco under the name of Television Laboratories Inc. to develop his own receiving (display) CRTs and his unique pick-up design. By September 1927, he had managed to produce a viable CRT based display which he called the oscillite, and was able to demonstrate that his image dissector could televise bright lines of light. By August 1929, the system could display a very simple silhouette image.

In 1930, Sarnoff, hearing of the developments, was sufficiently impressed, or perhaps worried, by the technical success of Farnsworth, that he offered to purchase the dissector invention outright for \$100,000. The offer was not accepted, and Farnsworth and his small team continued their development programme, although the fundamental lack of sensitivity of the image dissector was proving to be a major obstacle to progress. Even with their patented electron multiplier electrode structure and much improved photocathode materials, the light sensitivity of the image dissector was still inadequate. RCA's iconoscope, even with its storage characteristic, was only marginally adequate, but the image dissector was very seriously lacking in sensitivity, requiring vast amounts of light to produce an acceptable image.

In 1931, RCA's largest rival, the Philadelphia Storage Battery Co. (normally known as 'Philco'), began investing in Television Laboratories Inc. It was not a happy arrangement, with Farnsworth continually railing against the control and discipline of Philco's management, who wanted results faster than Farnsworth could deliver. This continued throughout the 1930s, but as of 1932 the Farnsworth image dissector was a functioning but extremely ineffective device for the intended application of live television broadcasting. The image dissector had some strengths in terms of picture resolution and freedom from secondary emissions, and it was effective in high light level applications, but the lack of sensitivity was always the inescapable problem. The image dissector did eventually have uses, but for mainstream live broadcasting the sensitivity was just too low. A unique application was the use of a

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<sup>437</sup> 'Community Chests' were local organisations in the United States who funded community projects by donations from businesses.

variant of the technology in the Apollo 11 moon landing where a very high light dynamic range handling was required. Some of the image dissector technology was ultimately used by RCA in the late 1930s (having purchased rights to its electron-multiplier system), but at the beginning of the decade it was the fear of competition and patent litigation that had the most profound effect on the reactions of the RCA management. The system worked, but not as well as RCA's, and Farnsworth's association with Philco failed to work out, leaving the technology and Farnsworth himself isolated and looking for further finance. The finance was found from Baird Television Ltd. (BTL) in Britain, who urgently needed all-electronic television technology, as I will explore more fully in Section 5.2.3. By the mid-1930s, the iconoscope was dominating all-electronic pick-up developments around the world, as I will describe in the next chapter. The image dissector was the only other potentially viable all-electronic pick-up technology in the Western world, but the lack of storage rendered the image dissector pick-up insensitive compared to the iconoscope, and apart from a few very specialist applications Farnsworth's technology fell into terminal decline by the late 1930s.

#### **4.6 A snapshot of all-electronic television development around the world as of 1932**

The development of all-electronic television was a transnational activity, with at least three centres of activity, each with links to the other via people and roots in the ideas of Rosing and Campbell Swinton. Before the mid-1930s only organisations in the United States, the USSR and Britain were taking any real and seriously active interest in all-electronic television, although some work was going on in companies and research organisations in France, Germany and Japan. Limited work was also going on in the laboratories of Philips in The Netherlands, and also in private laboratories in Hungary, but the main thrust of effort on the Continent was to be found in Germany and France. Other than the theoretical concepts of Campbell Swinton, work in Britain on all-electronic television as of the late 1920s and very early 1930s was primarily concerned with the receiving display CRT, especially regarding apparatus that could be used to view the existing electro-mechanically originated pictures. Such work was being pursued at GEC (the General Electric Company Ltd., not connected with the American General Electric), by A C Cossor

Ltd. and at His Master's Voice Ltd., (HMV) a gramophone company which became part of the Electrical and Musical Industries Ltd. (EMI) group formed in April 1931. Some research work on all-electronic pick-ups was also being carried out by HMV/EMI, as they were in receipt of advance patent information from RCA, but the effort was not extensive, even by 1932.<sup>438</sup> I will examine the all-electronic television developments of British and American companies more fully in Chapter 5.

In France, at least four scientists were involved with work on display CRTs; facsimile inventor, Édouard Belin, physicists Fernand Holweck, Ogloblinsky and engineering consultant Pierre Émile Louis Chevallier, all associated with Laboratoire des Établissements Édouard Belin at Malmaison. Their work on display CRTs was related to the receiving part of Belin's electro-mechanical facsimile machine, and by the late 1920s they had produced high quality electrostatically focussed tubes for the task. As I have already recalled, the team's technical knowledge was effectively carried to Zworykin's research group when Ogloblinsky emigrated to the United States to join RCA. The main thrust of French research into 'radiovision', as television was known in France at the time, continued to focus on electro-mechanical techniques, which continued well into the 1930s under leading proponents such as inventor René Barthélemy.<sup>439</sup>

Attention in Germany in the late 1920s was also mainly centred on electro-mechanical television (see Chapter 3), but as in France, work on display CRTs began to gather importance. Fundamental knowledge of CRT technology amongst scientists in Germany was strong, following the early work of pioneers such as Braun, Dieckmann and Glage. Work on developing display CRT technology in Germany was mainly carried out by large industrial concerns such as Telefunken GmbH, but besides the failed image dissector work of Dieckmann and Hell, little work on all-electronic pick-up was in progress in Germany as of the early 1930s. A variant of flying spot scanning, (described in Appendix 3.1), which used a display CRT to perform the flying spot scanning of the image, was successful. The originator of the

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<sup>438</sup> Abramson, *Zworykin*, 110-113.

<sup>439</sup> "French Television Experiments", *Practical Television and Short-wave Review*, 280. Describes French television work in 1935 which was predominantly electro-mechanical.

technique was scientist-inventor Manfred Von Ardenne, who found that due to the low light output from the CRT, he was limited to the scanning of small transparencies and film. The principal Japanese activity in electronic television in the 1930s was led by scientist Kenjiro Takayanagi of the Hamamatsu Higher Technical College. By 1932 had produced display CRTs, and was looking to replace his Nipkow disc pick-ups with iconoscope technology.

In the USSR, Rosing was released from the forest gulag in Archangel in 1932. He died in the spring of the following year. By 1932, the ‘Enthusiasts from Tashkent’ had been dispersed, never to work on television again, but there were other scientists and engineers in the USSR working on television. Pavel V Shmakov was concentrating on electro-mechanical techniques with CRT displays, and Boris V Krusser was pursuing a Soviet version of Zworykin’s iconoscope, succeeding with some results by 1934.<sup>440</sup>

In the United States, Zworykin and his team were making good progress with their pick-up technology based on the iconoscope. The display kinescope was in production, wide bandwidth radio transmitters had reached a satisfactory standard and sample consumer televisions had been manufactured. By 1932 RCA had a complete system, although still not meeting the required self-specified performance. The target specification, as laid down by RCA management, was to be an equivalent to ‘home movie’ – 16mm – quality, but on a smaller screen.<sup>441</sup> RCA knew that any home television system would be compared with the cinema, not only in terms of subject matter and artistic presentation but especially technical quality given the disappointments of the electro-mechanical systems. By the late 1920s the ‘movie theatre’ patron was able to experience a variety of entertainments at an affordable price and the public appeared to be fairly satisfied with the technical quality of the pictures, if not completely satisfied with the sound. RCA undertook research in the early 1930s to understand what a television system had to be capable of in terms of technical quality and the bench mark was invariably the cinema. RCA’s extensive

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<sup>440</sup> Gogol and Uralov, *Paul Vasilyevich Schmakov* 61-64; *Dunaevskaya, Klimin, and Uralov, Boris Vasilyevich Krusser*, 31-34.

<sup>441</sup> R.C.A., *Television*, 233-234.

technical papers describing this work were not made public until 1936, revealed as a book length account, but the work had been done some years earlier.<sup>442</sup>

Farnsworth and his team had achieved impressive results, but were hampered by lack of funds and encountered severe technical problems, largely due to the image dissector not possessing storage and thus exhibiting very poor sensitivity. Whilst Farnsworth was failing to solve the fundamental problems of his pick-up, his display CRTs had achieved a high standard of reproduction. RCA management did not see his technology as a threat to the technical supremacy of their iconoscope based pick-up, but the commercial competition might still be serious for them if Farnsworth and his team solved the image dissector sensitivity issues.

The promising, practical results achieved by Zworykin's team, was confirming to Sarnoff that all-electronic television was the only practical way forward for RCA. However, the amount of research and development required to create a whole system appeared to be too daunting for a practical service to be ready for use any time in the 1930s. Besides the technical difficulties, there were commercial pressures to avoid upsetting wireless set sales with talk of something better likely to appear soon (i.e., wireless with pictures). What Sarnoff really wanted from his technical teams in the early 1930s was not television, but a better quality wireless, free of 'static', fading and distortion, a 'little black box', as Sarnoff called it, to add to wireless sets.<sup>443</sup> To this end, RCA was investing heavily in improving wireless by pursuing research such as the work of wireless engineer Edwin Armstrong's Frequency Modulated (FM) system to improve reception. Sarnoff's stance changed as the prospect of a simple, cheap, 'little black box', to reduce 'static' (interference) receded, and the quality of the all-electronic television system and its commercial possibilities became evident.<sup>444</sup> Electronic television was just not an immediate priority for RCA in late 1932, but it was likely, in the long-term, to be a profitable success.<sup>445</sup>

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<sup>442</sup> Ibid., 107-145.

<sup>443</sup> Hughes, *American Genesis*, 147.

<sup>444</sup> Barnouw, *The Golden Web*, 40.

<sup>445</sup> Maclaurin, "Patents and Technical Progress", 147.



By 1932, all-electronic television was technically viable, but still needing more time and investment to develop to become a commercial reality. In addition, the time had to be right for the launch of a public service and that was not to be in the middle of the Great Depression and probably not even in the 1930s, but more likely into the 1940s, depending upon how long consumer confidence remained weak. In 1932 the chance of a public all-electronic television service appearing anywhere in the world in a short time frame appeared to be remote. The electronic television pick-up in particular needed large corporate resources to be developed to an acceptable level. The all-electronic CRT based method was the preferred path to viable television for the larger corporations, but to achieve technical and commercial success would require substantial investment in research and testing, a potentially very risky proposition in uncertain economic times.

#### **4.7 Conclusions**

Campbell Swinton and Rosing were at the heads of two parallel paths of television technology innovation. Rosing patented his invention whereas Campbell Swinton did not, preferring to write letters to journals and newspapers, lecture to learned societies and lobby influential individuals. Neither figure references the other, at least within currently known literature, but it is highly likely that each would eventually have had some knowledge of the other's work, at least up until the period of the Great War. Unfortunately, there is no direct evidence to confirm or deny possible communication. However, there is some circumstantial evidence of knowledge transfer via patenting systems and scientific periodicals. Rosing's patents in the United States, in Britain and Germany suggest that he was connected to channels of international communications and commerce, and it is likely that Campbell Swinton would have studied new patents in his field. By the early 1900s, *Nature* was already a significant international publication, and the likelihood of such a publication containing Campbell Swinton's idea reaching Rosing in Russia has to be fairly high. Nonetheless, I believe that the initial conceptions were independent, that they were indeed so, especially given the very close dates of the public disclosures, and of the known developments in CRT techniques and applications. This appears to be a genuine example of simultaneity.

Both Campbell Swinton and Rosing attempted to turn their ideas into practical reality; Rosing had very limited success, while Campbell Swinton abandoned his experiments very quickly. The concept of CRT based television then lay fallow for well over a decade. Electro-mechanical television, as achieved by the late 1920s, worked, but not well enough for any practical purpose. The possibilities of a new medium, however it might eventually be deployed, had been demonstrated, but something much better was needed in terms of picture quality for any practical application. As of the mid-1920s, the only known alternatives had few active proponents and no commercially significant backing. This changed when the twin tracks of the Russian/Soviet and British/American all-electronic technology became fused, following Zworykin's emigration to the United States. Initially, this was a one way information flow, with the Russian's knowledge being taken into the powerful corporate industrial machine of RCA, and developed by an able, well-funded, team formed specifically for the purpose. Ultimately, the technology was diffused back to the USSR, but the initial parallel and virtually isolated work by the 'Enthusiasts from Tashkent' suggest a different interpretation of the Rosing/Campbell Swinton concept based on photoconductive principles. The two networks were, for many years, cut-off from each other, with the well-funded Western developments producing viable and useful prototype product by 1932 and the independent Soviet work abandoned in the same year. Both of these development forks appear to be as a result of dissemination via networks of individuals working in the same field.

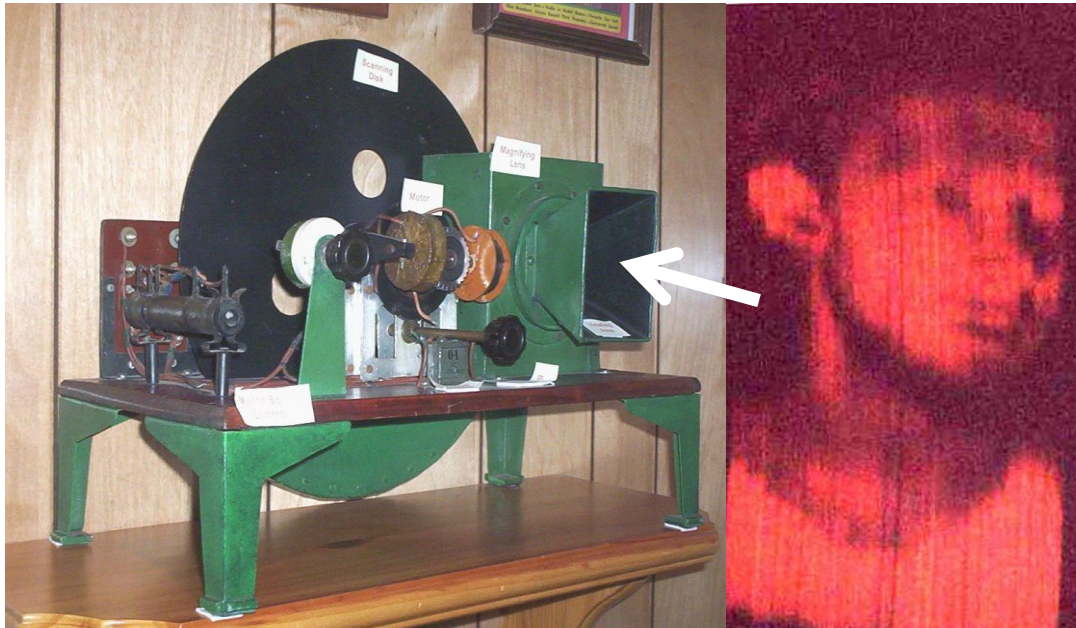
Another probable interpretation and practical realisation of the Rosing/Campbell Swinton concepts is the work of Farnsworth. Technically, his pick-up principle is off at a tangent to the Campbell Swinton idea, and it appears to have been developed as an electrical analogue of the Bidwell proposal. The root of his work is either multiple invention, or inspiration by Campbell Swinton/Rosing/Bidwell. I am persuaded by the likelihood of his having read the coverage of Campbell Swinton and others in the *Electrical Experimenter*, and that this was probably the source. It is thus highly likely that Farnsworth's work was inspired by Campbell Swinton and Bidwell, but again, there is no firm proof.

In Britain, Campbell Swinton was active right up until his death advocating all-electronic CRT based methods for television, and at the same time using all of his

powers of influence to denigrate Baird, his companies and electro-mechanical television in general. It is likely that Campbell Swinton's primary method of influence was verbal and in private, within the dining room of the Athenaeum Club and in other informal meetings. The response of the BBC, the GPO and the British Government was to keep their commitments to Baird and his companies at a relatively low level, until technical and organisational developments forced the Corporation to take a more proactive role, as I will describe in Chapter 6.

The early twentieth-century concepts of CRT based television were effectively disseminated by means of the patenting system, technical journals, magazines and speculative lectures. Although the information was specialist, and achieved only modest coverage, it appears to have reached relatively obscure places such as Rigby, Idaho and Tashkent, Uzbekistan. All-electronic television, as of 1932, was a reality, if not fully perfected, and the leaders were indisputably RCA. It is the diffusion, influence and effects of that company's work, both technically and commercially, that I will examine in the next chapter.

## Chapter 4 Figures



**Figure 4.1** Home made 30 line Baird standard television replica (made in the 1950s to an early 1930s design) and reproduced 30 line image (typically about 1.6 x 1 inch). The sample image is actually better than ‘live’ viewing as the flicker and continual image instability are not evident in a still picture. Image source: Author, Early Television Foundation Museum, Columbus, Ohio, United States. April 2006

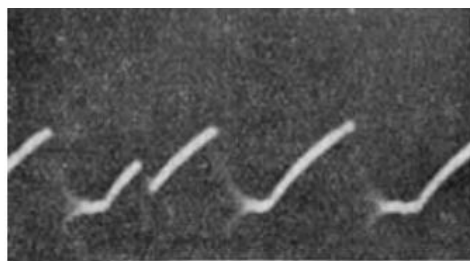


Fig. 1.

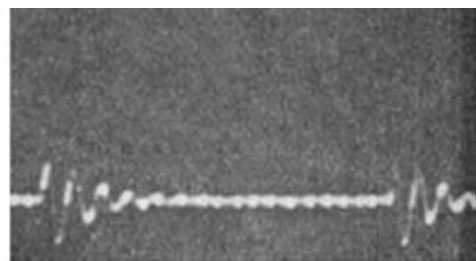


Fig. 6.

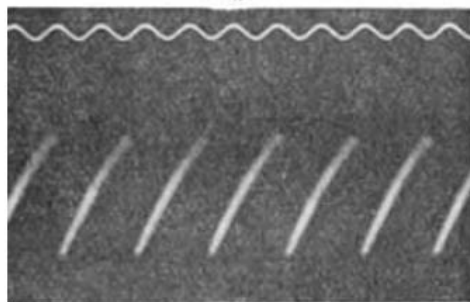


Fig. 2.

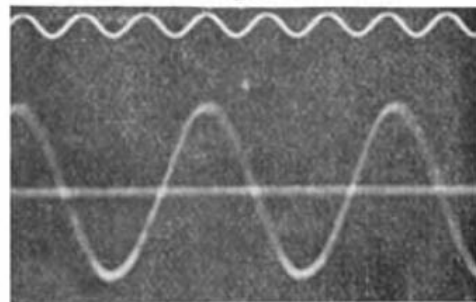


Fig. 7.

**Figure 4.2** Selection of oscillograph traces photographed from a CRT screen by A Wehnelt and B Donath. Picture source: Wehnelt, A., and Donath, B. “Photographische Darsetzung von Strom und Spannungs mittels der Braun'schen Rohre” Photographic Display of Current and Voltage Curves by Means of the Cathode ray Tube. German language” *Annalen der Physik*, Vol. 305, 1899, 861-870, 866



**Figure 4.3** Self-penned cartoon by Campbell Swinton following his election to the Royal Society. The caption, from *Lalla Rookh* (a book length poem by Thomas Moore set in the orient published in 1817) reads:

Paradise and the Peri.

"Joy, joy for ever, my task is done.  
The gates are past, and heaven is won!" Lalla Rookh

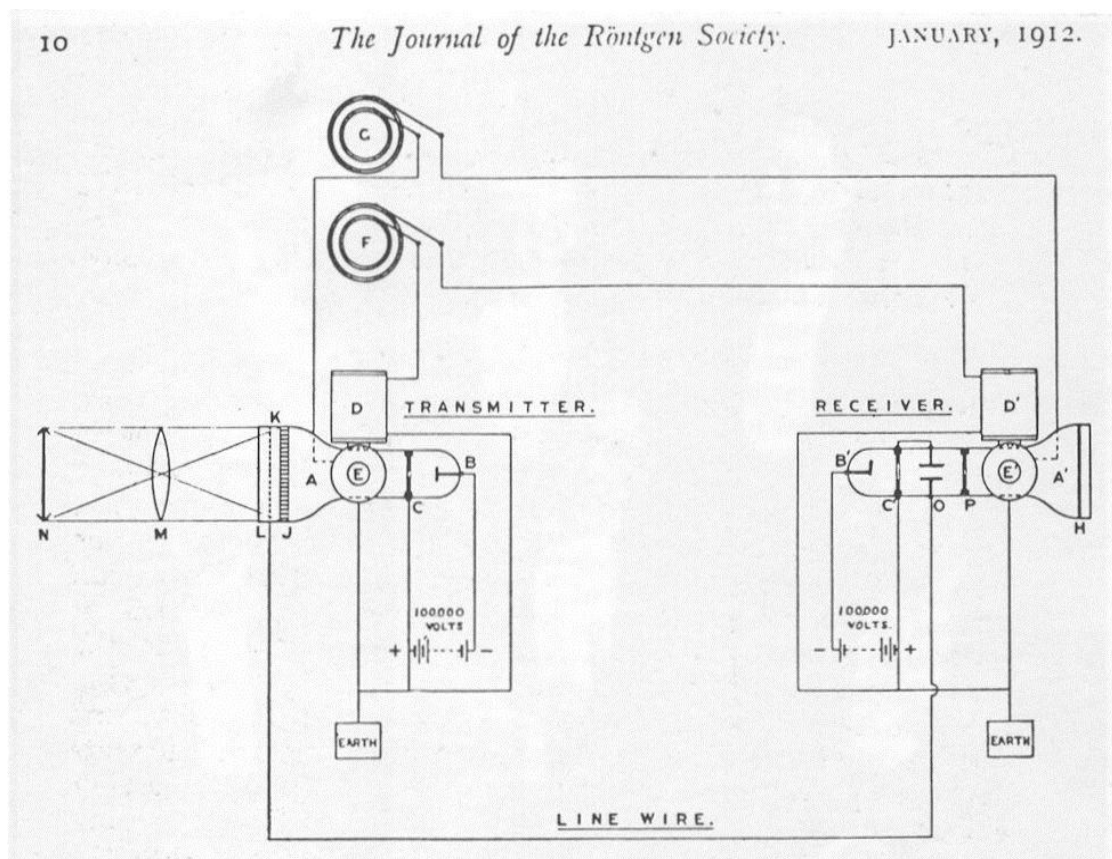
With apologies to "Punch" for

Feb. 28, 1874

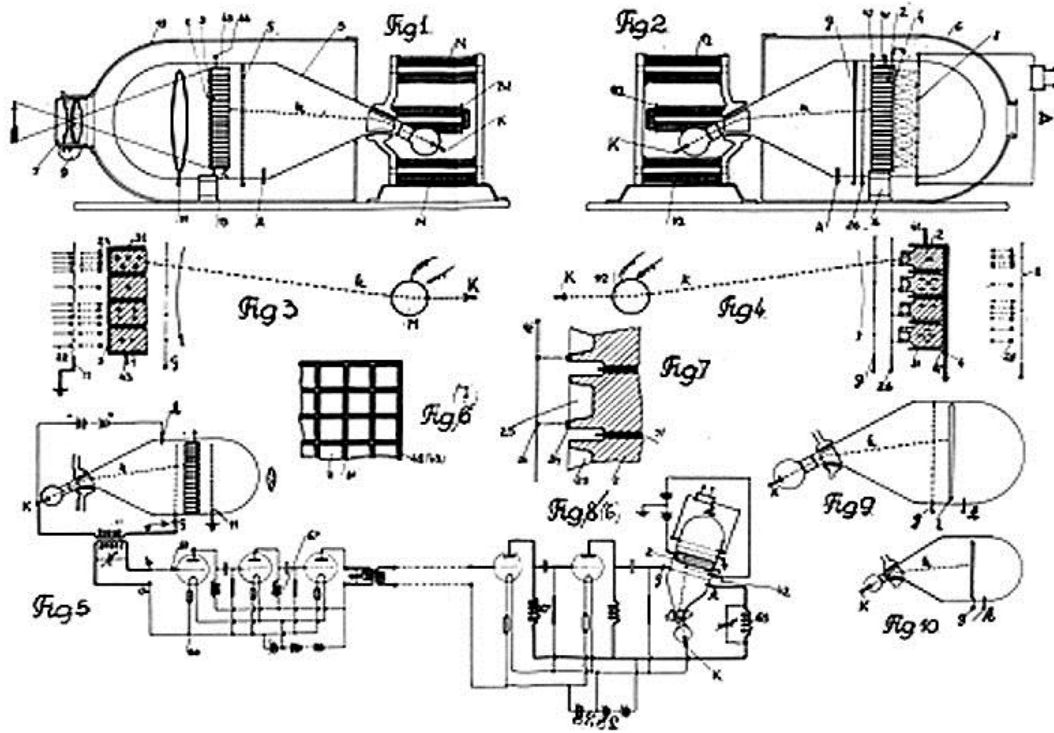
13<sup>th</sup> May 1915 A. A. C. S.

Picture source: Bridgewater, T H  
(1982) *A A Campbell Swinton*  
Royal Television Society, London.

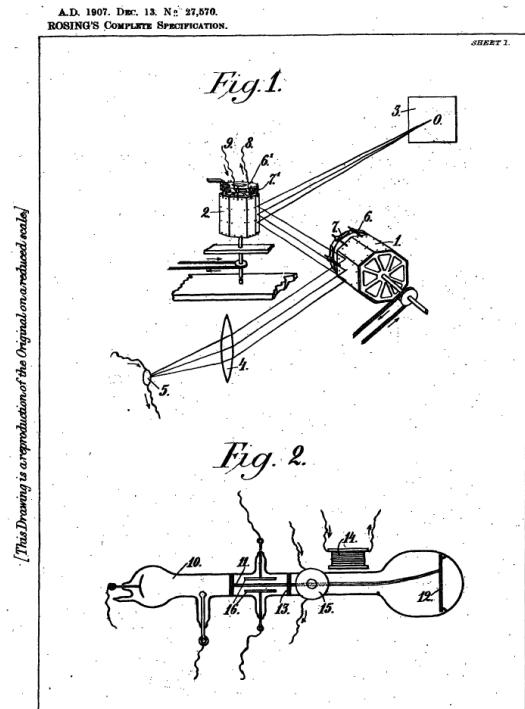
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**Figure 4.4** Campbell Swinton's suggestion for television as recorded by the *Journal of the Röntgen Society* in 1912. Picture source: Bridgewater, T H A  
*Campbell Swinton* Royal Television Society, London 21



**Figure 4.5** Kalman Tihanyi's Hungarian patent for electronic television, 1926  
 Image source: Russell Naughton <http://www.ctie.monash.edu.au/hargrave/tihanyi.html>  
 Accessed 09/15/2006



**Figure 4.6** Rosing's 1907 patent for television showing a mechanical camera scheme (top) with a CRT based display (bottom), granted in 1908. Image source: B L Rosing, British Patent No. 27,570. Date of application: 12/13/1907



# NEW ELECTRIC EYE 'MEMORIZES' IMAGES

By WILLIAM L. LAURENCE.  
Continued from Page One.

**Figure 4.7** *New York Times* headlines illustrate the sensational coverage (common for articles on television at the time) but the rest of the text is a quite detailed technical explanation of how it works. 'Memorizes' is a reference to the 'storage' effect of the Iconoscope. Picture source: *New York Times*, Jun 27 1933 New York, 1 and 15.

## HUMAN-LIKE EYE MADE BY ENGINEERS TO TELEWISE IMAGES

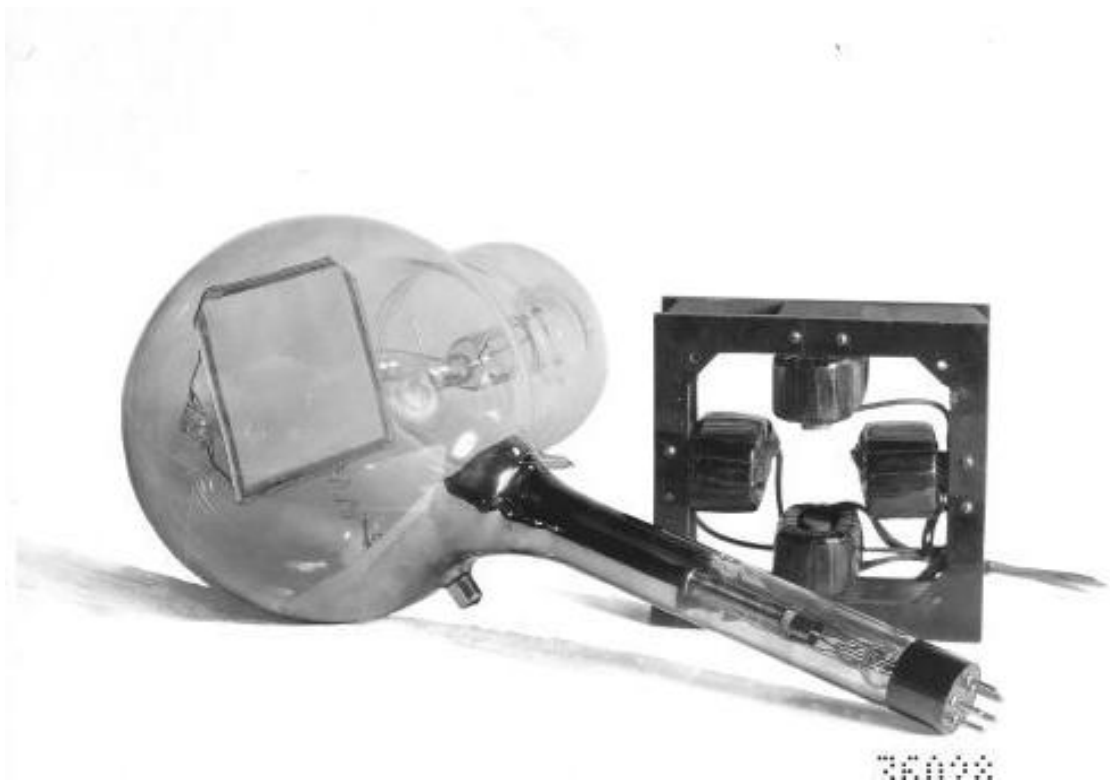
'Iconoscope' Converts Scenes  
Into Electric Energy for  
Radio Transmission.

## FAST AS A MOVIE CAMERA

Three Million Tiny Photo Cells  
'Memorize,' Then Pass  
Out Pictures.

## STEP TO HOME TELEVISION

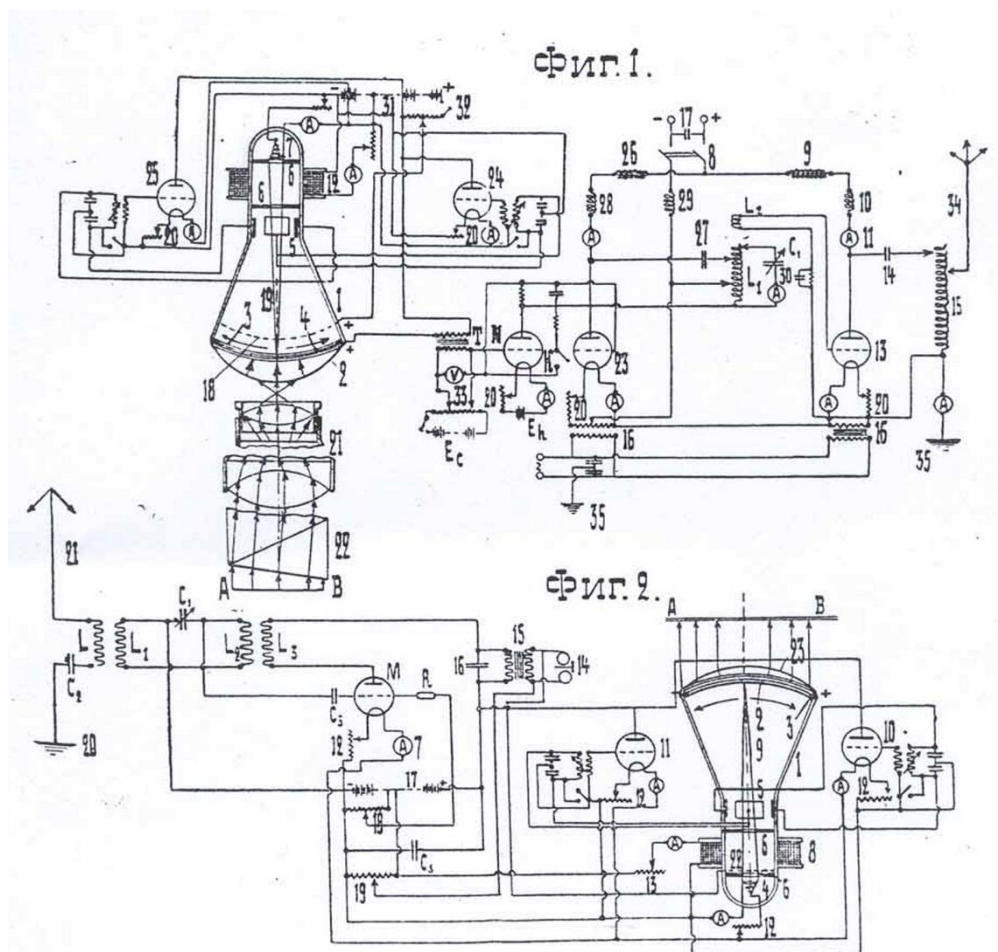
Developed in Ten Years' Work by  
Dr. V. K. Zworykin, Who  
Describes It at Chicago.



**Figure 4.8** Iconoscope pick-up tube of 1933 with deflection coil, as depicted in Zworykin's paper, "The Iconoscope - A Modern Version of the Electric Eye"  
Picture source: Alexander Magoun <http://www.davidsarnoff.org/gallery-tv-bw/Iconoscope-magnets.htm> Accessed 12/17/2006



**Figure 4.9** Zworykin televised on a kinescope screen by an iconoscope pick-up, believed to be in 1932. Picture source: David Sarnoff Library  
<http://davidsarnoff.blogspot.com/2007/12/david-sarnoff-vladimir-zworykin-and.html> Accessed: 01/14/2011

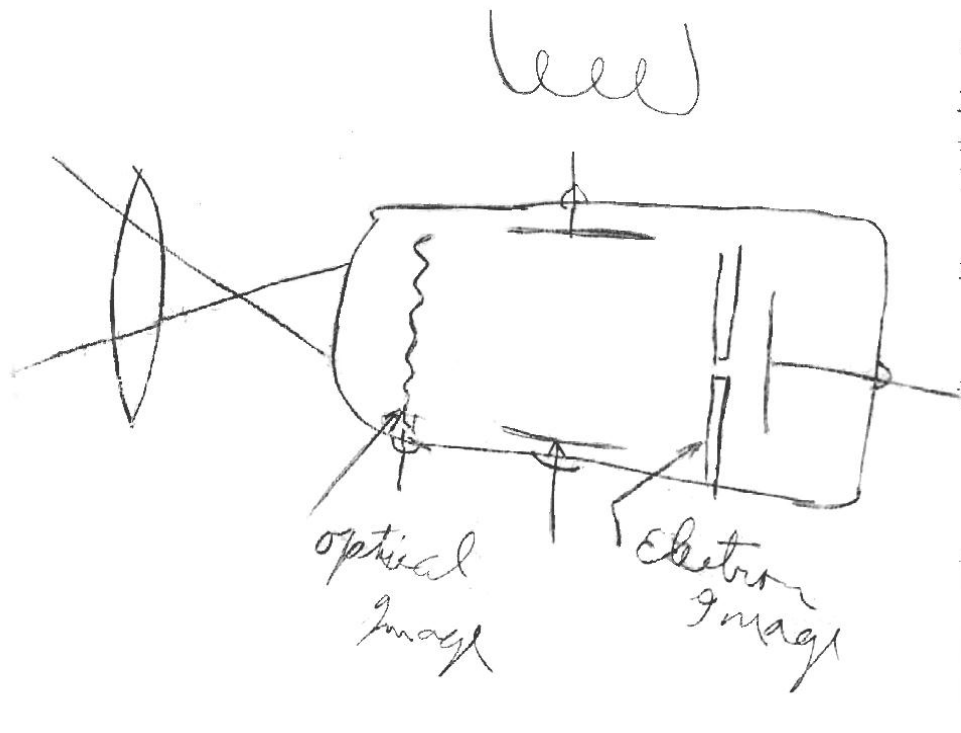


**Figure 4.10** Schematic of Grabovsky et al, Soviet patent for electronic television applied for in 1925, granted 1928. Camera is top left, display bottom right. Image Source: Russian Patent Office, Via L N Soms, St. Petersburg, Russia. V I Popov, B P Grabovsky and N G Piskunov, Russian Patent No. 4899, Applied for on 09/11/1925  
 Image source: Russian Patent Archive, Moscow





**Figure 4.11** Philo T Farnsworth and image dissector camera (head only, a very large amount of external electronics was also needed). Date: about 1934. Picture source: Kent Farnsworth <http://www.philotfarnsworth.com> Accessed 11/06/2006



**Figure 4.12** Farnsworth's sketch of 1921, drawn for his teacher Justin Tolman, of his idea for a pick-up device - the image dissector. Picture Source: Kent Farnsworth [http://philotfarnsworth.com/actual\\_sketch.htm](http://philotfarnsworth.com/actual_sketch.htm) Accessed: 12/13/2006

## **Appendix 4.1**

### ***The Principle of ‘storage’ in pick-up devices***

One of the largest problems facing all of the early television pioneers was that of sensitivity, the ability of a camera to produce pictures in relatively normal levels of light. The very earliest electro-mechanical systems employing Nipkow discs, Weiller’s drums or Szczepanik’s mirrors, all lacked storage – they only responded to the instantaneous light level as sampled by the scanning system. This meant that for a 30 line picture, with 12.5 frames per second and perhaps the equivalent of 40 pixel points across each line, each pixel would be exposed to the light for a fraction of only  $1/30 \times 40$  per frame, or about 0,83 milliseconds in every television frame of 800 milliseconds, a ratio of about 1,000:1. This is a very short duty cycle, and severely limits the inherent opto-electrical efficiency. A better system would see each pixel exposed to the scene image light for the whole frame period, with that value sampled on a pixel per pixel basis, and then quickly reset back to zero before the start of the next frame. This would, in theory, result in a thousand fold increase in sensitivity. In the case of high resolution, all-electronic television, with perhaps 343 lines, 300 effective pixels across each line and 60 pictures per second, the ratio works out to be about 1,600:1 and rises rapidly as the resolution increases. This was the problem with Farnsworth’s image dissector, it did not ‘store’ or integrate the incident light over a frame period, resulting in a huge deficit of sensitivity compared to the iconoscope, which although not perfect in this respect, was considerably more sensitive.

**Figure 4.13**

Farnsworth’s wife, Pem, features in this picture. On the left, a photo with eyes closed against the very bright light. On the right, the television picture. Picture source: <http://davidsarnoff.blogspot.com/2007/12/david-sarnoff-vladimir-zworykin-and.html>

Accessed: 01/14/2011



## Chapter 5

### ***International Rivals and Allies in the Competition for Television Supremacy***

#### ***5.1 Introduction***

In the last chapter, I explored the origin and dissemination of the proposals made in the early twentieth century for all-electronic television, and how from the late 1920s to the very early 1930s, such ideas began to challenge the still nascent electro-mechanical television systems for the interest of manufacturers, broadcasters and consumers. This challenge involved a shift from the very small-scale research facilities in electro-mechanical television development, to large corporate laboratories working to perfect the much more complex and very expensive all-electronic technology. The corporate affiliations and rivalries relating to this new work straddled the Atlantic, and relationships forged in the early days of wireless and gramophone development played a major role in shaping the direction of television research. Whilst the economics of launching an all-electronic television service during the Great Depression were not favourable, the companies involved were readying themselves for an upturn in the consumer market.

In this chapter, I will review the relationships of the principal industrial players in the corporate quest for a viable, practical, all-electronic television system, and how these interactions led to a rapid development phase in the United States, Britain, and to a lesser extent, Germany. British and American developments centred on creating a commercially viable public broadcast system to the home, whereas the German work was largely shaped by the potential of television technology for propaganda dissemination via public viewing rooms.<sup>446</sup> Work in other countries was limited to companies and researchers making improvements to some of the parts of an all-electronic system, such as that of Belin in France with regard to display CRTs, but there was no major commercially driven whole system activity, almost all work was in academic laboratories.<sup>447</sup>

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<sup>446</sup> Magoun, "Adding Sight to Sound" .

<sup>447</sup> Burns, *Television*, 274.

Besides the direct commercial and political forces shaping the direction of all-electronic television development, there was also influence from important regulatory bodies, notably the GPO and BBC in Britain, with the FCC (Federal Communications Commission), performing a similar regulatory role in the United States.<sup>448</sup> In Germany, the ambitious political objectives were initially under the control of the propaganda ministry directing industrial developments, with the Reichspostzentramt [National Central Post Office], charged with running the television service.<sup>449</sup>

Political and commercial considerations aside, before an all-electronic television service could actually be introduced to the public, all of the constituent technical parts of the system had to be developed to a satisfactory, yet still to be quantified, standard. The standards required of the system parts depended upon many factors, including the place of reception (home, public viewing rooms or cinema), the material to be televised (films or live action), the technical standard of reproduction anticipated by users, the anticipated costs and the geographic coverage required. For live pick-up, the best technology of the 1930s was RCA's iconoscope, which the company shared with several foreign firms. In Britain, the technology was shared with a new collaborative company which was formed in March 1934 between MWTCO. and EMI, bearing the name Marconi-EMI Television Company Ltd.<sup>450</sup>

Contemporary questions of shared patent rights, and how the new technology was perceived by the general public, broadcasters, regulators and other potential users shaped the course of this development phase. For Marconi-EMI, the question of the country of origin of the all-electronic technology became a potentially serious problem. The British public's perception of television was that John Logie Baird had already 'invented' it, as a result of all of the publicity surrounding his electro-

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<sup>448</sup> The FRC (Federal Radio Commission) became the FCC in June 1934.

<sup>449</sup> "The German Viewer's Service", *World Radio*.

<sup>450</sup> "A New Television Company", *World Radio*. The decision to form the joint venture of Marconi-EMI Television Company Ltd. was taken in March 1934 and registered on May 22, 1934, see: Marconi's Wireless Telegraph Co., Ltd., (1934) New Television Merger. Press release May 22, 1934, Marconi Archive, Bodleian Library, University of Oxford, MS. Marconi 325.

mechanical systems. The BBC and GPO had to take note of this fact, as his company, Baird Television Ltd. (BTL), was ever keen to point out that Marconi-EMI was using American technology and was partly American-owned.<sup>451</sup> Baird used the American origin of the Marconi-EMI technology in an attempt to shame the BBC into co-operation with BTL with regard to transmission facilities. In personal letters written by Baird and BTL's vice chairman, Sydney Moseley, to the Director General of the BBC, Sir John Reith, the Prince of Wales and the Postmaster General (Sir Kingsley Wood), he complained several times on BTL's behalf in terms such as: 'the tentacles of the American Radio Trust' [RCA] ... have force[d] a means of muscling in through the back doors of the BBC ... through its subsidiaries [EMI].<sup>452</sup> In contrast to this position, BTL was successful in minimising private and public awareness of its own later adoption of American technology, in the form of Farnsworth's image dissector. Similarly, its close links with German companies and technology appear to have generated no concerns in the press or within the BBC/GPO.

It was assumed in contemporary reports in the United States that the Marconi-EMI work was simply a copy of that of RCA. The British work was regarded as a clever and thorough development, but a copy of the RCA work nonetheless.<sup>453</sup> Conversely, in contemporary British reports, once an initial period of secrecy was over, the impression was created that the Marconi-EMI work was a distinctly separate development.<sup>454</sup> There has been a tendency for the history of early television

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<sup>451</sup> Burns, *Television*, 333.

<sup>452</sup> Burns, *British Television*, 252-262 describes the long sequence of communications over the activities of the American 'Radio Trust' and BTL's credentials as a British company. The quotations come from: POST 4004/33 Moseley, S A Letter to Sir Kingsley Wood, Jan 28, 1933, Minute. Post Office Archives.

<sup>453</sup> Marsland-Gander, "Television race", Jun 30 1935 Describes EMI as 'developing a television using Zworykin's electric 'eye' using RCA patents and cooperation.

<sup>454</sup> "The first complete details", *Television and Short-wave World*. This lengthy and detailed technical article in an early 1936 popular television magazine does not mention RCA, Zworykin or the iconoscope at all. A year earlier, in the more authoritative *Wireless World*, in a 32 page supplement on television, it is very briefly speculated that Zworykin's iconoscope '... seems likely to be used [in the Marconi-EMI transmissions]'. See: "The Wireless World Television Guide", *Wireless World* (Supplement).

development to be written from a nationalistic or company-centric viewpoint, this has then been echoed in subsequent narratives, according to the country of origin. This self-perpetuating process has been observed by media historian William Uricchio.<sup>455</sup> Whilst this can be a common trait of accounts of invention written in the technologically deterministic tradition, the nationalism in this case is particularly powerful. Gauging contemporary public perception about a technology's country of origin is difficult from newspaper reports alone, but as BTL persisted in the practice of stating the company's position, it was probably a useful ploy.

In the first part of this chapter I will outline the principal industrial concerns working towards an all-electronic system of television in the early 1930s, and how two discrete transatlantic groupings formed; one principally around RCA, the other around BTL. The RCA affiliated companies were all connected by long standing commercial links, and personal ties forged by people crossing from one company to another. The other transatlantic association was formed primarily around BTL in Britain and Television Laboratories Inc. in the United States. Both of these companies were very much smaller than RCA, with its many associated companies, so did not have the corporate resources available to the major wireless concerns. The other major difference between the two groupings was that BTL was focussed solely on television systems development, and being a small organisation could respond more rapidly to developments than could the larger corporations.

In the second part of this chapter I will examine the RCA affiliated companies and their technologies in more detail, concentrating on relationships between companies and how the core technology of the iconoscope was adopted in Britain, amid patriotic controversy largely created by rivals BTL. I will describe how the longstanding MWTCO. and RCA agreements operated in practice in the early 1930s, and then explore how the emergence of EMI altered the dynamics of their television related patents and future relationships. The disposal by MWTCO. of its consumer wireless manufacturing division effectively split its patent rights in two: the firm retained those patents concerned with transmission, but lost the receiving-related

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<sup>455</sup> Uricchio, "The Oxford Handbook of Film and Media Studies", 293-294.

patents to EMI. I will then explore the interplay between the three companies with regard to all-electronic television technology, and in particular the initial development phase of the iconoscope pick-up tube for live all-electronic television. EMI's work its equivalent iconoscope equivalent 'emitron' pick-up led to the accusation that it had adopted 'American technology', or worse, was part of the monopolistic American pact known as the 'Radio Trust'. The case suggests a duality in the relationship of the American and British companies' activities: they operated simultaneously as rivals and allies, with an appropriate public presentation in each country. To conclude my study of this transatlantic corporate relationship, I will investigate an alternative hypothesis, one which could explain the relationship as a more detached one: that the technologies were not as complex or difficult as has usually been accepted, but this does not appear to have been likely, at least initially.

In the final part of this chapter, I will contrast the activities of the RCA affiliated grouping with another transatlantic corporate relationship, that of the much smaller BTL and its associated companies. BTL's struggle to acquire all-electronic television technology from the United States is complicated by its shifting commercial goals, and also by its German associate company's own changing circumstances, which in turn were being shaped by the need for a rapid deployment of television in Germany for political purposes. RCA management's vision for the deployment of all-electronic television centred squarely on the 'wireless with pictures to the home' model, whereas BTL had two potential markets in mind. The first followed the same model as that of RCA, but the second related to large screen television cinema. I will explore how the new owner of BTL after 1932, the Gaumont British Film Corporation Ltd., began to shape the company's commercial and technical goals in pursuit of television delivered to the cinema screen and the televising of films to the home. This study of the two groupings takes the narrative of television development up to around the beginning of 1935, a period when interactions between the two rival groupings became public in Britain in the form of a technology competition, a theme which I will explore fully in Chapter 6.

## ***5.2 The principal industrial companies at the centre of the development of all-electronic television***

Whilst the main technical developments in all-electronic television occurred in the very early thirties, the interlocking histories of the companies concerned go back much further, to the late 1890s. Evidence of these linkages at work can be found in unexpected places. The image of ‘Nipper’ and the gramophone (Figure 5.1) remains a familiar advertising icon (albeit now often stylised) to consumers throughout the world.<sup>456</sup> Painted in 1898 by Francis Barraud, the picture was adopted by the Gramophone Company in Britain and first appeared in company advertisements in 1900. An American corporation, the Victor Talking Machine Company, was given rights to the image at the request of the inventor of the gramophone, Emile Berliner, and upon the purchase of the Victor Talking Machine Company by RCA in 1929, the rights to the image passed to RCA. To an American, the image still symbolises the home-grown corporate giant RCA, even though the initialism itself is now no more than a brand name.<sup>457</sup> In Britain and Commonwealth countries, the association of Nipper is with His Master’s Voice (HMV), now a chain of record shops, but originally one of the founding constituent companies of EMI Ltd., along with the Gramophone Company and Columbia Graphophone. The common image reflects a shared heritage forged in the first three decades of the twentieth century. It is this complicated network of international industrial association that was at the heart of all-electronic television development in the 1930s.

The principal research groups involved were largely manifestations of the well-established wireless and gramophone companies. There was competition from smaller rival specialist companies focusing solely on television work. These specialist companies grew rapidly following investment from other wireless companies left out from the main groupings and from allied industries such as cinema. The main thrust of activity was in the United States and Britain, but German operations gathered pace from early 1933 with encouragement from a government

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<sup>456</sup> Ostergaard, “The History of Nipper”.

<sup>457</sup> Although RCA no longer exists as a manufacturer in its own right, the brand name lives on in consumer electronics and media products, as does the image of Nipper, although he is now free from his master’s gramophone.



which saw television as a potentially useful new propaganda medium. A small number of companies dominated television research in the early 1930s, but a few specialist companies such as Dumont Inc. in the United States and Cossor Ltd. in Britain, existed alongside the industry leaders. Such organisations were typically not working towards a complete system of television, but developing television receivers, specialist niche products for the television industry, or researching novel approaches to problems.<sup>458</sup>

Developing all-electronic television required abilities across a wide range of the physical sciences, engineering technologies and craft skills. The intensive demands that all-electronic television placed on applied physics and chemistry required high-quality groups of researchers recruited largely from universities. To support the development processes, the teams needed ancillary skills specific to the wireless industry: in particular, glass-blowing, the fabrication skills for making intricate hand-made parts for tubes, and the winding of precision-wound components (inductors and transformers). Blown glassware was particularly important, and the skill was taken to new levels of complexity in the fabrication of CRTs and high power transmitter valves, both dependent on the highly developed talents of a few individual craftsmen.<sup>459</sup> Some of the older established companies, such as MWTCO., had acquired reserves of such specialist resources and possessed skills in all of these fields, yet as I described in Section 3.5, MWTCO. was not particularly interested in developing television other than as a specialist accessory for point-to-point communications.

In the early 1930s, the most active company in television research (both electro-mechanical and all-electronic), was undoubtedly RCA, but another major industrial concern, the Philadelphia Storage Battery Co. (usually referred to as Philco) was a

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<sup>458</sup> *Television Today*, 358-364. A C Cossor Ltd. was working on a novel scanning system known as velocity modulation; “Dumont, Allen B”,

<http://www.museum.tv/eotvsection.php?entrycode=Dumont> Accessed: 22/02/2011. Dumont Laboratories was founded in 1931 by engineer Allen B Dumont and initially specialised in manufacturing CRTs.

<sup>459</sup> Lécuyer, *Making Silicon Valley*, 28. Notes the importance and rarity of the glass blower’s art to thermionic technologies of the 1930s.

major rival. Other large American companies such as General Electric were also active in the field, but RCA and Philco were much more heavily committed. These large American concerns were challenged by Farnsworth's Television Laboratories Inc., a small start-up company with innovative all-electronic television technology as described in Section 4.6. In Britain in the very early 1930s, the bulk of television research work was being undertaken by two companies: the newly formed EMI Ltd., pursuing the earlier work of founding constituent company HMV, and Baird Television Ltd. (BTL). MWTCO. had only limited interest in television technology, as I described in Section 3.5, but did possess considerable know-how and patents in wide bandwidth transmission technology.

In Germany, Telefunken AG had significant system-level work in progress rivalling that of the British and American companies, but most of this effort still utilised electro-mechanical pick-up technology. To facilitate its all-electronic television aspirations, Telefunken simply elected to buy rights to the RCA iconoscope pick-up technology, and proceeded to make its own copies of both the tube itself and of the supporting electronics. A new start-up company in Germany, Fernseh AG, derived from the German name for television (fernsehapparat, shortened to fernsehen), was also addressing the problems of a complete television system. The company was formed as a joint operation by four existing firms specifically to develop television systems. Further details of all of these companies are given in Appendix 5.1, which summarises their origins and corporate heritage. As single companies they were significant and influential in the development of all-electronic television, but it is their relationships to each other that had significant effects on the shaping of the technology and the direction of television as a new medium. I will now consider these relationships in more detail.

### ***5.2.1 Inter-company relationships***

The corporate relationship between MWTCO. and RCA was constrained by previous inter-company legal agreements, share holdings and personal histories. The development of television was producing large numbers of patents and also patent disputes, but the agreements on reciprocal rights between the two companies set up in 1919 on the formation of RCA largely held, creating a transatlantic patent pool in

the technology.<sup>460</sup> Smaller, specialist companies, approaching television as their only concern, were free to form alliances and create agreements as the contemporary situations required. BTL was such a company: it did not have the long established resources of the older, larger wireless companies such as MWTCO., but by collaborating with other companies, possibly even foreign ones, it could acquire resources and technology. Such collaboration enables companies to retain their independence, without the constraining difficulties sometimes created by acquisitions and mergers. Today, this is common practice, but in the 1930s it was rare, especially when undertaken on a transnational basis. Collaboration between companies in the development of all-electronic television came into being for two reasons: past, shared heritage with legal obligations and voluntary associations. Both shaped the direction of research and the commercialisation of the technology. The relationships between co-operating companies were not just commercial in terms of share holdings, subsidiaries, technical know-how, patent agreements or shared contracts, but often much more personal in terms of old loyalties and friendships forged from shared experiences, such as had been formed within the world-wide operations of MWTCO., especially before and during the Great War.

As of the very early 1930s, it was not clear which companies would choose to affiliate with which others, if any, but amongst the large companies, the old alliances provided a basis for development. By 1933 two loose groupings were beginning to emerge, and I will refer to them as ‘Marconi-RCA’ and ‘Baird-Farnsworth’. The relationships of the affiliates within these two groups waxed and waned as commercial and technical opportunities and obstacles appeared, but by 1934 the groupings were essentially quite firm. However, if Baird’s personal recollections are correct, events and decisions could easily have exchanged the members of the groups, with Marconi partnering BTL and RCA buying Farnsworth’s Television Laboratories. In his autobiographical notes, Baird recalled a ‘numerous meetings’ with MWTCO. representatives at their main factory in Chelmsford over a potential merger, but how serious the negotiations really were remains unknown.<sup>461</sup> This possibility was finally and fully abandoned with the formation of Marconi-EMI in

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<sup>460</sup> Baker, *A History of the Marconi Company*, 181.

<sup>461</sup> Baird, *Sermons Soap and Television*, 127.

1934. RCA's potential purchase of Farnsworth's Television Laboratories Inc. was abandoned in May 1931, following a personal visit by RCA's Sarnoff to see Farnsworth at his San Francisco premises.<sup>462</sup>

Figure 5.3 is a summary depiction of how the Marconi-RCA relationship came together and Figure 5.4 similarly describes the Baird-Farnsworth grouping. Although by the time of the partnership, BTL had been taken over by the Gaumont British Picture Corporation, the grouping still did not have the financial resources of Marconi-RCA, but it did possess a major television patent pool, comparable, at least initially, to that of its much larger rival. I will now examine the two groupings in more detail.

### **5.2.2 The Marconi-RCA grouping**

With reference to Figure 5.3, the historical heart of the Marconi-RCA grouping is MWTCO., in many of its forms, names and branches, even though a number of these were absorbed or sold and ultimately merged with others. A common element of the grouping is the origin of some of the major individual actors in the narrative as Russian émigrés. It should not be assumed, though, that MWTCO. itself was at the heart of the principal technical developments in all-electronic CRT based television. The main technical impetus came from RCA, and via the interlocking patent rights in the group this technology was disseminated back to other companies within the Marconi 'family'. It was the key technology of the RCA iconoscope pick-up which enabled much of the grouping's technical lead, stimulating further research and development to solve the system level problems associated with it.

There were two main branches within the grouping, the American and British, but there was also a fairly small German association. The main links between the British and American branches relate to the foundation of RCA from American Marconi and GE's wireless interests in 1919. Shared ownership of the Victor Talking Machine and British Gramophone Companies by EMI Ltd. and RCA effectively gave RCA a large share-holding in EMI Ltd. upon its formation in 1931. These relationships were all concerned with gramophones, gramophone records, sound recording technology,

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<sup>462</sup> Abramson, *Zworykin*, 104-105.

wireless broadcasting and wireless communication. Television in the early 1930s was of little commercial significance and not a factor in affecting the purchases, take-overs or mergers that formed this complex web of relationships. The links forged by gramophone and wireless interests helped to shape the development of all-electronic television by putting into place a network of patent cross-licensing, people, money and, to some extent, politics.<sup>463</sup> A major split occurred with MWTCO.'s sale in 1929 of its consumer wireless manufacturing business to HMV. This took with it all of MWTCO.'s patent rights to RCA patents associated with domestic receiving equipment. All of the 'transmission' patents (including television and facsimile) remained with MWTCO., as did the right to make receivers for non-consumer applications. The formation of Marconi-EMI in 1934 effectively restored the links between the domestic receiver market and that of transmission for EMI and MWTCO., at least so far as television was concerned.

A further complication arose from the patent pool and the commercial agreements formed between RCA, General Electric (GE) and American Telephone and Telegraph Company (AT&T). This pact, often referred to as the 'Radio Trust', was an arrangement whereby each of the members made its patents available to the others at no cost. For ten years, AT&T would have exclusive manufacturing rights to radio-telephony and transmitters, with GE having similar rights to wireless telegraphy and receivers. RCA had the exclusive rights to what had been American Marconi's communications empire, plus they would handle all patents plus sales and service for the pact members. The Radio Trust ultimately fell-foul of American anti-trust legislation in 1932 and was broken up, but not without causing considerable concern both domestically and internationally over its dominating and monopolistic practices.<sup>464</sup> Even after 1932, RCA was viewed with some suspicion by rivals, regulatory authorities and governments around the world.<sup>465</sup>

Three Russian émigrés form another major thread in the transatlantic links between the companies in this group: David Sarnoff (manager/president, American Marconi,

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<sup>463</sup> Friedrich and Sternberg, "Congress and the Control of Radio Broadcasting", 210.

<sup>464</sup> Bitting, "Creating and Industry", 32.

<sup>465</sup> Friedrich and Sternberg, "Congress and the Control of Radio Broadcasting", 809-810.

RCA), Vladimir Zworykin (scientist/engineer/group leader, Russian Marconi, Westinghouse, RCA) and Isaac Shoenberg (patents specialist and manager, Russian Marconi, EMI and Marconi-EMI). All three had been employees or closely associated with MWTCO. in one form or another. Sarnoff began his career with American Marconi and Zworykin and Shoenberg had both been associated with Russian Marconi. Shoenberg had been an employee, later emigrating to Britain to work for the parent MWTCO, and Zworykin had been involved with lengthy military secondments to the Russian Marconi factory in St Petersburg. It is difficult to establish formal evidence that this shared Russian heritage influenced relationships, but correspondence between Shoenberg and Zworykin reveals some firm evidence of personal friendship<sup>466</sup> and the Zworykin/Sarnoff relationship appears to have been one of mutual respect, trust and friendship, even to the extent of Sarnoff managing to facilitate trips to the Soviet Union in the 1930s for Zworykin.<sup>467</sup>

The story of Sarnoff has often been presented as an example of the idealised American notion of hard work and ability taking individuals from rags to riches. The patriotic story culminates with Sarnoff being recruited into the army with the rank of General, over-seeing American electronic communications strategy during World War II. He is often referred to as 'The General' by post-war journalists and writers.<sup>468</sup> His story begins with Sarnoff leaving Russia for the United States with his parents at the age of nine in 1900 to eventually become an office boy at American Marconi in 1906, his personal lobbying of Guglielmo Marconi leading to his rapid rise through American Marconi's hierarchy. Following the creation of RCA by the nationalisation of American Marconi in 1919, Sarnoff completed his corporate rise by becoming the president of the new all-American company in 1930.

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<sup>466</sup> Shoenberg, I. Sarnoff Library Archive (1933-1935). Letters, Zworykin Collection: Trips and Conferences Series, England, 1929-1937 (Box 4, folder 2). Letters to Zworykin, Aug 21, 1933, Dec 6, 1933, Aug 22, 1934, Oct 8, 1935. RCA Archive.

<sup>467</sup> Abramson, *Zworykin*, 137.

<sup>468</sup> The 'all-American' hero image of Sarnoff is described in many publications and websites such as Stashower, *Boy Genius and the Mogul* and the David Sarnoff Library website at <http://www.davidsarnoff.org/dsindex.html> Accessed 08/29/2008.

Sarnoff was the commercial driving force behind the RCA decision to invest in television and continue to do so through the Great Depression. Although able to understand the technology of television, he was not a scientist, inventor or engineer, but a powerful corporate manager, possessing sufficient technical knowledge to fully understand difficulties and opportunities. With RCA as a major shareholder in EMI until 1935, Sarnoff also had a position as a director on the EMI board and this continued until December 1944, even after the final buy-out of RCA shares.<sup>469</sup> Zworykin's early all-electronic research has been described in Chapter 4, resulting in RCA successfully developing a viable all-electronic television system by 1933.

Earlier, in 1931, television research at RCA was proceeding on similar but not identical lines to those of the British company HMV, largely relying on CRTs for receiving displays but working on both electro-mechanical and all-electronic techniques for pick-up.<sup>470</sup> In the case of HMV, the pick-up work was limited to creating suitable picture signals to enable their receiver work, whereas RCA had commercial interests in both ends of the television system. Following the formation of EMI in 1931, the new board decided to continue with television research, resulting in a strengthening of the EMI (the former HMV) research team, assembling a team of engineers and scientists together with a budget of £100,000 per year.<sup>471</sup> The new British company, EMI Ltd., had its own Russian émigré scientist to champion all-electronic television in the form of Shoenberg who was appointed in 1931. He was not an advocate of direct cooperation with RCA, especially as the rights to any transmission work that the firm might develop from RCA technology belonged to MWTC., and in any case, as a consumer-led company, EMI had to concentrate its resources on the potentially profitable business of domestic television receivers. EMI needed picture sources to test and develop such receivers, and it is from this requirement that the initial interest in pick-ups and picture sources probably began. As Shoenberg stated in a letter to Zworykin: 'We will not be interested in the Iconoscope as a transmitter because our field will be restricted,

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<sup>469</sup> Jones, "The Gramophone Company", 98.

<sup>470</sup> Ibid., 435-437.

<sup>471</sup> Ibid., 443.

roughly speaking, to television reception'.<sup>472</sup> Shoenberg continued in his role after the formation of Marconi-EMI in 1934 and led the team to the successful creation of the Marconi-EMI system of all-electronic television, creating a major rival to RCA's dominance, yet using the same core technologies.

Shoenberg was unusual in British industry in the 1930s, in being part corporate manager and part scientist/engineer specialising in patents, exercising a considerable degree of autonomy and being subject only to the EMI board of directors.<sup>473</sup> By way of comparison, Zworykin was a scientist/engineer with few corporate duties effectively reporting directly to Sarnoff, who in turn as the senior corporate manager was responsible to the board and able to facilitate the necessary funding for comprehensive all-electronic television research.<sup>474</sup> Sarnoff had faith in Zworykin: even when his predicted costs to develop all-electronic television began to rise well above initial estimates, investment and research continued.

The Marconi-RCA grouping was never a formal partnership, and rivalry is as much a part of the narrative as is co-operation. It is this duality which makes the relationship such a vital, yet little understood one in the shaping of all-electronic television in the 1930s. The rivalry between Marconi-EMI and RCA became a competition for technical superiority, particularly in terms of picture quality and public perception, yet their pooling of patents and of know-how benefited both sides. RCA gained in terms of the security of its patents and in improvements in the detail of its technology. Marconi-EMI gained from RCA television systems research knowledge and the technology of the iconoscope. Neither company expected rapid returns on their investments in television research; this was work performed in anticipation of new markets and opportunities for exploitation when the Great Depression eased.

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<sup>472</sup> Shoenberg, Sarnoff Library Archive (1933). Letters, Zworykin Collection, Trips and Conferences Series, England, 1929-1937 (Box 4, folder 2). Letters to Zworykin Oct 12, 1933. RCA Archive.

<sup>473</sup> Mowery, "Firm Structure, Government Policy, and the Organization of Industrial Research", 507 compares British and American research, describing the former as having weak industrial research management due to there being few engineers in senior positions before World War II.

<sup>474</sup> Bitting, "Creating and Industry", 55 and 98 Describes Sarnoff's effective autonomy and generous funding given to the Zworykin/Engstrom television research.



### 5.2.3 The Baird-Farnsworth grouping

In contrast to the Marconi-RCA grouping, Baird-Farnsworth was eventually a formal partnership, although the companies completely retained their separate identities.<sup>475</sup> As a new company, BTL's lineage is naturally much less complex than that of Marconi-RCA and this is reflected in the very much simpler structure presented in Figure 5.4, showing the British, American and German elements of the grouping. BTL's tie-up with the new joint ownership company Fernseh AG in Germany dated from 1929, and was an important company resource in terms of trade and technical ideas. The American link with Farnsworth's company came much later in 1934, injecting much needed new all-electronic technology, something which the German associates did not possess.

As I have already suggested, German and American links might not have been Baird's own preferred course of action. An apocryphal story has Baird ruefully recalling a conversation with Mr Andrew Gray, the General Manager of MWTCO.:

“Good morning,” I said.

“Good morning,” said Mr. Gray.

“Are you interested in television.” Said I.

“Not in the very slightest degree. No interest whatsoever” said Mr. Gray.

“I am sorry to have wasted your time. Good morning,” I said and immediately walked out in high dudgeon.<sup>476</sup>

Gray had been a near neighbour of Baird in his childhood home in Helensburgh, and Baird had had some expectation of at least a hearing. This story undoubtedly feeds the Baird legend, but whatever the truth behind it is, it does illustrate his own view of his dealings with large organisations as being rather unsuccessful, which they were. His relationship with the BBC was no better, and had always been precarious with the Corporation continually questioning the value of his 30 line work. It was not until he began to use more commercially astute men to help him, such as former

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<sup>475</sup> Everson, *Philo T Farnsworth*, 147.

<sup>476</sup> Baird, *Sermons Soap and Television*, 47-48.

journalist and politician, Sydney Moseley, that his company began to make more commercial progress, as demonstrated with the formation of Fernseh AG, which was facilitated largely by him.<sup>477</sup> The new foreign enterprise enabled BTL to further its interests in television on the Continent, and also to harness German technology to help develop its own work. BTL's quarter share in Fernseh AG was helpful to both parties, but came to its commercial end with the ascendancy of Hitler, as orders were given that British interests in the company must cease.<sup>478</sup>

BTL, still under the technical direction of Baird himself in 1932, would not accept all-electronic pick-up technology, largely because it was not his invention. As the work of the Marconi-RCA grouping was revealed in the form of the iconoscope pick-up (and Marconi-EMI's version, the emitron), it became clear to BTL management that they had to have their own all-electronic pick-up technology to compete.<sup>479</sup> Baird lost direct control of BTL in the late summer of 1933 following the take-over of the company by the Gaumont British Picture Corporation, largely because of his intransigence with regard to CRT-based television, although he was eventually happy to accept it as a display device. By late 1933, BTL's management was desperate for all-electronic technology to rival the iconoscope and the only known source, other than RCA, was Farnsworth in the United States. An opportunity arose when a two-year contract between Farnsworth's Television Laboratories Inc. and Philco ended in 1933, leaving the former company without financial support. Various reasons have been suggested for Philco not renewing the contract ranging from lack of progress to Farnsworth being 'difficult', or pressure from RCA exerted in the form of threats about radio licences.<sup>480</sup> BTL needed all-electronic pick-up technology and Farnsworth needed financial backing, which made a co-operative deal between the two highly desirable.

BTL, with its electro-mechanical television systems experience gained via its association with the BBC's 30 line experimental transmissions, had an enviable

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<sup>477</sup> Burns, *British Television*, 158.

<sup>478</sup> Baird, *Sermons Soap and Television*, 121.

<sup>479</sup> Kamm and Baird, *John Logie Baird*, 252-255.

<sup>480</sup> Stashower, *Boy Genius and the Mogul*, 198.

knowledge of the whole television process and its needs. Farnsworth had none of BTL's transmission and operations knowledge, but he did have the image dissector pick-up and display CRTs, as I described in Section 4.6. Farnsworth's company, Television Laboratories Inc., was desperately short of funding by 1934, and BTL, via its principal investors, had asked for \$50,000 to strike the deal for rights to the dissector. To the managements of both companies, the arrangement appeared to be a near-ideal partnership.<sup>481</sup> The linkage was logical, but fraught with potential commercial difficulties and technical rivalry. Baird and Farnsworth, as individuals, had a similar view on business exploitation of their ideas: they wanted to retain as much control as possible, and would not surrender anything without a fight.<sup>482</sup> Both also had complete faith in their own technical ideas, although they were at odds with each other over the actual technology. Such potential conflicts were avoided because by the time of the deal in 1934, Baird was no longer in control of BTL, although he was still active within it.

At a personal level, Baird and Farnsworth were similar people in as much as they were examples of the last traces of the 'lone inventor'. Both had achieved success in the field of a demanding new technology and both had keenly courted publicity. Throughout the 1930s, Baird remained unwilling to accept that electro-mechanical pick-up systems would not be able to compete with the all-electronic systems in development. Another apocryphal Baird story has him walking away dejectedly after seeing the all-electronic Farnsworth pick-up for the first time, realising that the electro-mechanical era of television was over.<sup>483</sup> By mid-1933, Baird had completely lost any control of BTL, but continued to work for the company from his private laboratory, and was still funded by it.<sup>484</sup>

Another member of this grouping, although strictly more of a contractor, was Metropolitan-Vickers Ltd. of Manchester which possessed specialist high-power transmitter technology. Whilst BTL had built its own low-power television

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<sup>481</sup> Ibid., 206-207.

<sup>482</sup> Ibid., 141; Burns, *John Logie Baird*, 86.

<sup>483</sup> Stashower, *Boy Genius and the Mogul*, 205.

<sup>484</sup> Kamm and Baird, *John Logie Baird*, 252.

transmitters, it did not have the means to design and build transmitters for the ultra-short wave (usw) having the required output power; Metropolitan-Vickers had this capability.<sup>485</sup> German companies might have been able to design such units for the group, but Metropolitan-Vickers already had considerable experience with the required technology.<sup>486</sup> It was also British and not subject to the political uncertainties of another German linkage.

#### **5.2.4 The broadcaster's view of the groupings**

In the United States, any prospective broadcast user of an all-electronic television system was likely to be tied to one of the large wireless corporations developing it. In the case of the National Broadcasting Company (NBC) this was RCA, and for the Columbia Broadcasting System (CBS) it was Philco. Such a broadcaster of the early 1930s faced three problems: the commercial difficulty of launching such a service during the Great Depression with the likely impact on sound wireless broadcast receiver sales, the ban by the FCC on carrying advertising due to the 'experimental' nature of television, and finally, an issue not faced by the BBC, the sheer geographic size of area to be covered.<sup>487</sup> RCA operated two wireless networks: the Red Network, mainly running very high power stations with national coverage, and the Blue Network, operating lower power local stations with partial national coverage. These networks, based on affiliated privately owned stations, were huge by the early 1930s, with all of the United States covered by one or both networks. In terms of station numbers, the CBS network of affiliates was larger than either of RCA's and had similar national coverage. All of these wireless transmissions were on the long, medium and short wavebands which could effectively cover the whole country with fairly modest investment in transmitters and aerials. This would not be case with higher-definition television.

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<sup>485</sup> Ultra-short wave is now termed VHF (Very High Frequency) and is usually taken to be in the region of 30 to 300 Mc/s. In the 1930s anything over 30 Mc/s was described as ultra-short wave.

<sup>486</sup> Allibone, "Cecil Reginald Burch", 16-17.

<sup>487</sup> Western, "Television Girds for Battle", 530. Even as late as 1939, the FCC ban on 'selling air time' on television was still in place.

The FRC had already recognised the problem of television's excessive requirement for radio spectrum space (as I described in Section 3.3.3), and this would only become worse with improving picture resolution and quality with more visual information to transmit. RCA's studies pointed towards the ultra-short wavebands, where there was plenty of spectrum space available as a solution. High-power broadcast transmission on the usw bands was untried and known to have very short line of sight range. Such transmissions do not conform to the curvature of the earth as long-wave ones do, and they do not bounce off of the ionosphere as those in the medium/short region do. This meant that powerful transmitters with very tall antenna towers and multiple transmitter sites would be needed for usw television transmissions.<sup>488</sup> This presented any broadcaster with a serious problem, if national network coverage similar to wireless was envisaged, in the sheer capital cost of the huge number of transmitters and antennas. Only experimental all-electronic television stations operated in the United States before 1939, owing mainly to the reluctance of RCA and Philco to launch such expensive services that might hurt their already profitable wireless interests.

In early 1930s Britain, the BBC, as an independent broadcaster, faced different problems. Its management already feared a near monopoly of wireless equipment supply controlled by MWTCO. The company dominated the supply of technical facilities, and although the performance was generally good, the BBC resented being restricted, and sought alternative supply where possible.<sup>489</sup> It would have been politically difficult for the BBC to purchase foreign equipment and technologies, so it was left with MWTCO. and a handful of minor competitors. There was also a certain amount of rivalry between MWTCO. and the Corporation: MWTCO. was the first British broadcaster with its transmissions from Writtle, Essex, and was one of the founders of the original British Broadcasting Company in 1922, which became

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<sup>488</sup> In the United States, the term *antenna* is used in preference to *aerial* as used in Britain and the British Empire.

<sup>489</sup> Pawley, *BBC Engineering*, 132-134. Offers an example of BBC disdain for MWTCO. This relates to the Marconi supplied Daventry long-wave transmitter specially developed for the BBC and the involvement of Metropolitan-Vickers and Standard Telephones and Cables (STC) in subsequent requirements.

the British Broadcasting Corporation in 1926.<sup>490</sup> Most of this friction was at a low level, but there were occasional flare-ups. An example from 1923 relates to MWTCO.'s wireless broadcasting technical tests from Writtle, drowning out the British Broadcasting Company's transmissions. The Company's reaction was to poach the Marconi engineer responsible, Peter Eckersley, appointing him as its own Chief Engineer.<sup>491</sup>

Demonstrations of all-electronic television developments by manufacturers after late 1933 revealed rapidly improving prototypes, resulting in the reinforcement of BBC fears about monopolised equipment supply in the new arena of television, especially after the emergence of Marconi-EMI Ltd: MWTCO., it seemed, was effectively in a position to become the dominant supplier of capital equipment for television, as well as for wireless. The other grouping, Baird-Farnsworth, was regarded by the BBC as not being as technically advanced, although possibly viable eventually. Baird-Farnsworth posed a different potential threat to the BBC, a threat to its own monopoly of British broadcasting.<sup>492</sup> The company had previously presented a formal challenge to the BBC when the Corporation refused BTL access to its transmitters to establish an experimental 30 line service; resulting in Baird investigating the possibility of establishing and running his own broadcast television service.<sup>493</sup> The proposals were rejected by the licensing body, the GPO, but the idea of a television service, entirely separate to sound wireless and not run by BBC, became a credible threat. The BBC had no choice but to continue with both of the possible suppliers, with reservations about both.

In Germany, with Hitler in power by January 1933 and in full control by March the same year, the prospect of large screen television opened up a fresh potential use for the new medium. Large-screen television systems were thought of by the Nazis as the television equivalent of a public address sound system, and development was

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<sup>490</sup> The MWTCO. transmissions from Chelmsford, call sign 2MT, are covered in: Wanda, *2MT Writtle*, which also explores the early relationship between the company and the BBC.

<sup>491</sup> Milner, *Reith*, 96 and 98.

<sup>492</sup> Burns, *British Television*, 95. Describes Baird's 1928 discussions with the GPO about his application for a broadcast television transmission licence beyond 'experimental' station status.

<sup>493</sup> See Section 3.4.

encouraged.<sup>494</sup> Relaying public events and propaganda to large cinema audiences was attractive to the Nazi Minister of Propaganda and Public Enlightenment, Joseph Goebbels, and BTL's large screen technology was in tune with this German idea of a 'visual' public address system. The company was making good technological progress in this field, and Germany offered real commercial possibilities until the enforced separation by the new German government.

In 1933, BTL was in strong position, covering all of the potential applications for television, principally the 'wireless with pictures' and telecinema. With Gaumont British financing the research and development activities and good commercial prospects, the future appeared bright, especially as the BBC was fully co-operating with the company's 30 line work in running its own service using BTL facilities from the BBC's Broadcasting House.<sup>495</sup> The BTL board was also actively pursuing the need for much higher technical quality, especially for use in the cinema.<sup>496</sup> Baird himself suggested that: 'I believe that one of the largest fields for television lies in the cinema of the future'.<sup>497</sup>

### ***5.3 Rivals yet allies: the Marconi-RCA grouping and all-electronic television technology.***

Despite their shared history and firm patent exchange agreements, the companies comprising the Marconi-RCA grouping were rivals yet allies at the same time. The nature of the transatlantic links between them were mainly those forced upon them by the United States government following its effective nationalisation of American Marconi, and did not directly include shared commercial activities or responsibilities. Both sides, including the related German companies, were free to sell and operate in their own right and in each other's countries. There were no commercial or governmental trade restrictions on, for example, MWTCO. selling wireless broadcasting transmitters to a US broadcaster, or to RCA selling wireless broadcast antennas to the BBC. In reality, the rest of the world (excluding the British

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<sup>494</sup> Burns, *Television*, 326.

<sup>495</sup> Bridgewater, *Just a few lines*.

<sup>496</sup> See Section 3.5 and Brown, "Electronic Imaging", 205.

<sup>497</sup> Baird, *BBC Year Book*, 447.

Empire to a large extent) was open for competitive business, but in firms' home countries a degree of protectionism existed by virtue of the patriotic loyalty of customers (whether real, in the form of government import restrictions, or by fear of public perception), as well as restrictions imposed by the formation of the 'Radio Trust'. An example of the transatlantic agreements in operation is the diffusion of the successful RCA ribbon microphone design: a version made by MWTCO., first manufactured in 1934, became the famous 'BBC lozenge' model, officially known as the Type A (see Figure 5.2). The BBC was free to buy this microphone from RCA, but owing to the high cost preferred the similar design from MWTCO., which had the right to produce it under the patent agreement with RCA.<sup>498</sup> There was no real competition for the capital goods side of the wireless business between the companies within this grouping: they were rivals but largely protected by government favour.

A similar situation existed on the consumer side of the industry, with transatlantic trade in the field of wireless sets being very small in total, hampered by protectionist import controls on spare valves and a hostile indigenous industry.<sup>499</sup> It is highly unlikely that the technical difficulties of differing mains voltages and slightly differing broadcast bands would have prevented export/import trade: a rival American company, Philco, did succeed in Britain with large sales of wireless sets, albeit only as a fraction of the British total.<sup>500</sup> The situation changed indirectly with RCA's purchase in 1929 of Marconiphone, the consumer wireless manufacturing division of MWTCO., which ultimately became part of EMI, but there was still little in the way of physical goods crossing the Atlantic either way, either before or after the sale.

The prospect of all-electronic television did not immediately change the nature of the near-term commercial sales situation, but technical co-operation and rivalry between the transatlantic associates was a different matter. I have already described the

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<sup>498</sup> Pawley, *BBC Engineering*, 120; Beckwith, "Old BBC Radio Broadcasting Equipment and Memories".

<sup>499</sup> Geddes and Bussey, *The Setmakers*, 183.

<sup>500</sup> *Ibid.*, 182.



reciprocal patent rights enjoyed by MWTC<sub>o</sub>., EMI and RCA, but this does not fully explain the situation regarding non-patentable proprietary knowledge relating to inventions and technologies. Patents are not the only way of securing protection for an invention, and even when patents have been taken out there can still be processes and techniques that are not fully described. Another option for protection is absolute secrecy, and both RCA and EMI used this alongside their patents. Since the inception of the American patent act of 1793, United States patents must, by law, include a written description, in the case of a machine, of how it works and how it can be made. The act, which is still in force in an amended modified form, originally directed that the inventor:

. . . and shall deliver a written description of his invention, and of the manner of using, or process of compounding the same, in such full, clear and exact terms, as to distinguish the same from all other things before known, and to enable any person skilled in the art or science, of which it is a branch, or with which it is most nearly connected, to make, compound, and use the same.<sup>501</sup>

The legal requirement for disclosure was clear, but in the case of a complex invention such as the iconoscope television pick-up tube, building a successful device from just the patent would be very difficult, even for ‘any person skilled in the art’. A lot more information and experience would be needed along with specialist equipment and proprietary techniques. Could EMI have constructed a successful iconoscope without direct RCA help in 1932? Evidence to confirm that it did survives in the form of a physical tube (see Figure 5.5b), and claims by EMI researchers.<sup>502</sup> Without more detailed guidance from RCA, it is unlikely that the EMI emitron tube could have been developed further. The practical details of the physical construction of the CRTs, the processing of the photo-emissive target and many mechanical and electronic details would all have required ‘hidden’ proprietary knowledge to successfully build working versions. Such tacit knowledge would have been acquired over time by the RCA engineers and scientists, working day-to-day with the technologies.

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<sup>501</sup> “Patent Act of 1793, Ch. 11, Section 1 Stat. 318-323 (Feb 21)”, United States of America: 1793.

<sup>502</sup> McGee, “E.M.I. Cathode Ray Television Transmission Tubes”, 131-132.

Differentiating between acquired explicit and tacit knowledge could, perhaps, be tackled by a close examination of the surviving laboratory records and notes relating to RCA's television developments.<sup>503</sup> However, to assess the likely difficulties in skills transfer would require much guess-work and with no surviving laboratory personnel to corroborate and explain the background to the information, any conclusions would be hazy. Converting tacit knowledge into explicit knowledge is sometimes possible, but would be difficult in cases such as glass-blowing techniques, the mosaic sensitisation processes and circuit design philosophy. Difficulties arise with defining what was explicit and what was tacit in terms of the knowledge base and also how actors might have converted tacit to explicit knowledge. Such general questions have been examined by sociologist Harry Collins and can be applied to this specific case of knowledge transfer.<sup>504</sup> However, there then still remains the question of whether the RCA board actually wanted to share the information. Be it tacit or explicit, the knowledge could be disseminated, and with the known extended visits of EMI personnel to the RCA laboratories, that knowledge was surely passed on to some degree.

In contrast to the controversy surrounding the emitron, the other important technologies of the whole television system, those of the transmitter and the domestic receivers, all appear to have been developed by several companies in the early 1930s, all exhibiting very different techniques. Marconi-EMI's television transmitters were derived from MWTCO.'s SWB-8 short wave sound broadcasting transmitters, while the RCA designs came from that company's own work on similar short wave transmitters. There were also other differences relating to the technical detail. Marconi-EMI stressed the importance of 'DC working' in television systems generally and went to great technical lengths to achieve this, whereas RCA disregarded the issue completely, relying solely on the technically far simpler AC

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<sup>503</sup> There are surviving volumes of technical laboratory notes collated by RCA engineer Harley Iams (RCA Archive), but they would require a detailed survey and interpretation in order to pursue an investigation of explicit versus tacit knowledge accumulation in the RCA laboratories.

<sup>504</sup> Collins, *Tacit and explicit knowledge*, 5 and Chapter 3 examines the problems of differentiating between explicit and tacit, and also the issue of conversion.

coupling.<sup>505</sup> Such divergence in developmental detail does set Marconi-EMI and RCA apart, but this was not apparent in the design and development of domestic receivers. The HMV display CRT which became the EMI ‘emiscopé’ shared much with RCA’s ‘kinescope’, including its phosphor composition.<sup>506</sup> Compared to the emiscopé/kinescope, the development of the iconoscope was much more demanding of the contemporary technology, and therefore a much more useful measure of co-operation and/or rivalry. I will now examine the iconoscope and emitron pick-ups in more detail in search of simultaneous rivalry and co-operation between RCA and Marconi-EMI.

### **5.3.1 The RCA iconoscope and the EMI emitron: two incarnations of the same invention**

In terms of operating principles, the two tubes are identical, but the extent of shared information between RCA and EMI can only be gauged by available records and circumstantial evidence. There are no known records of a formal co-operation between RCA and EMI on pick-up tubes, other than the patent exchange agreements in place at the formation of EMI Ltd. The iconoscope, using descriptions of a 1933 RCA type (all other versions are very similar), operates as described in Appendix 5.2. The operation and construction of the tube is disclosed in US Patent number 2,141,059, filed in December 1923 but not finally granted until December 1938 after a long dispute over its validity, largely relating to the key issue of storage as I described in Chapter 4, Appendix 4.2. A working tube could not be made along the lines laid out in the patent without a considerable number of changes and the addition of practical details. A later patent, US Patent number 2,065,570 filed February 1932 and granted in December 1936, describes how to make the photo-emissive mosaic (the photocathode), the most difficult part of the tube to construct and to understand. Besides the patents, RCA had accumulated considerable secret proprietary information and techniques in order to develop the iconoscope technology. It could control the diffusion of the iconoscope not just by controlling

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<sup>505</sup> Unpublished evidence to the Television Committee POST 33/4713 Parts 1 to 4 Marconi-EMI technical evidence to the Television Committee. Post Office Archives.

<sup>506</sup> Abramson, *Zworykin*, 145.

the patents, but by withholding the associated proprietary knowledge. The original patent does not explain, or even refer to, the following issues:

1. How the photocathode is divided up into pixels, i.e., how the signal plate mosaic is formed. In order to address only individual pixels with the scanning beam, it is necessary for the mosaic to be comprised of minute pixels insulated from each other. In this way, the accumulated charge is unique to that pixel and not to its neighbours. Furthermore, each pixel operates as a charge storage capacitor bringing huge improvements in sensitivity due to the storage (integration) effect.
2. How the secondary emission effects can be minimised and overcome. The iconoscope class of tube is known as a 'high velocity' camera tube, in that the scanning electrons strike the mosaic with a relatively high velocity causing secondary electrons to be emitted, leading to severe image shading and black level distortions.
3. How the photocathode is processed and activated. The technology of the photocathode was very new, and all the materials and processes involved had been produced by a combination of a limited theoretical understanding and lengthy trial and error experiments. Knowledge of the exact methods of the formation and activation would save anyone attempting to build an iconoscope a considerable amount of time.
4. How the raster correction to create a rectilinear image is achieved. The angled electron gun causes a trapezium-shaped raster, rather than a rectangular one, to be described on the photocathode mosaic. This shape must be corrected, either at the optical image stage, or in the scanning electronics, to avoid gross spatial image distortion.

These were all complicated problems, involving fundamental electron physics, materials chemistry, specialist craft skills, new forms of electronic circuitry and optical design. By 1932 Zworykin and his team had managed to solve, or at least to minimise, all of these problems to a reasonable functional level. Item 2 was never fully eradicated: the severe picture shading that the problem generated was only minimised by adding controls known as 'tilt' and 'bend', adding sawtooth and parabolic correction signals to the picture, continually adjusted by an operator as the scene being televised changed. The sensitivity, despite the tube possessing the

storage integration effect, was also marginal, but despite these problems the large RCA development team had the iconoscope pick-up system working quite well by early 1933. Shoenberg and the EMI board of directors did not decide until mid-1933 to add transmission (studio and transmitter equipment) to their consumer television development activities and had a considerable amount of work to do to equal the same level of performance as that already achieved by RCA. Why the EMI board decided to embrace transmission is not known, especially as EMI was not then in a strong financial position, having only made a £300 profit the previous year.<sup>507</sup> As of mid-1933, EMI had considerable work to do to equal the RCA all-electronic television technology with regard to the iconoscope pick-up, and if it managed to achieve success the company had no patent rights to use the core techniques. For EMI working alone, to develop a viable all-electronic pick-up which did not infringe RCA patents, and which did not require RCA's help, would probably be a long and expensive development process. This question of American origin of the EMI developments was exploited by BTL in public and private assertions about RCA and its 'unwanted' influences in Britain. Without access to the currently unavailable EMI Ltd. archives, the full extent of inter-company co-operation can only be gauged from evidence in the RCA archive and memoirs of the people involved.

Assuming for a moment that the emitron was a straight copy of the iconoscope television pick-up, built with RCA co-operation, then that is simply a matter of industrial technology sharing. If the iconoscope and the emitron were the products of individual teams reaching the same technical conclusions in similar circumstances, then an example of simultaneity of technological development is demonstrated. This would be an illustration of the idea that inventors merely complete a long sequence of events, and that there will always emerge 'somebody' to do that.<sup>508</sup> Whilst this is probably true in the case of all-electronic television being based on CRT technology, given the invention of the CRT oscillograph, the evidence of collaboration and the detailed similarities in the case of iconoscope and the emitron do not suggest

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<sup>507</sup> Norman, *The Story of British Television*, 101. EMI profit 1932-3.

<sup>508</sup> The question of simultaneity was discussed in Section 1.2.1, but also see: Macleod, *Concepts of Invention*, 145-146. Discusses questions with regard to '... the last links in the chain'.

simultaneity. In addition, there were other contemporary possibilities for pick-up tube construction, as I have shown in Chapter 4. I will now explore the evidence for collaboration in more detail.

### **5.3.2 Co-operation or simultaneity – the evidence**

A timeline in Appendix 5.4 details the known visits and significant events in the RCA and EMI/Marconi-EMI development programmes, but this is only a limited summary of known communications. In the absence of a detailed trail of exchanges and communications, I will now consider the conflicting recollections of the developments of the emitron. The controversy over EMI's originality may have begun as contemporary industrial propaganda, put out by Baird and BTL, to undermine the patriotic credentials of EMI and Marconi-EMI, but it grew into something of a running sore with some EMI researchers. Dr. J D McGee, a Cambridge graduate specialising in high-vacuum technology, was a leading member of Marconi-EMI's television development team, and was always keen to make the case for EMI originality. Many of his comments were made in the late 1930s, but they continued right up until his death in 1987. Below is his own summary of his position on the EMI work:

It has been said that the Emitron (made at EMI) was a straight copy of the iconoscope (made by the RCA) and that we at EMI were largely dependent on know-how from the latter company. One reason advanced for this is that the tubes look similar. Now I can state categorically that there was no exchange of know-how between the two companies in this crucial period between 1931 to 1936. And with regard to the similarity of the tubes it would be clear to anyone with a minimum technical perception that given the situation as it existed at the time when we did not know how to make an efficient transparent signal plate or photo-mosaic, there was no other way in which a tube could be constructed.<sup>509</sup>

McGee, as a senior member of the EMI team, held several television patents and was one of Shoenberg's most important researchers; in a position to have been involved

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<sup>509</sup> Norman, *The Story of British Television*, 105.

intimately on a day-to-day basis with the whole of the EMI work. His evidence concerning the extent of RCA contributions to the EMI work has to be taken seriously, but to suggest that there was only one way to make a tube is unconvincing. The work of Grabovsky and his team in the Soviet Union and that of Farnsworth (as I described in Chapter 4) confirms that the iconoscope/emitron was not the only way of creating a viable pick-up tube in the 1930s. It is not known how good (or bad) Grabovsky's tube was, but it was certainly not based on the photo-emissive principle of the iconoscope and the Farnsworth tube was not even a CRT. The 'Enthusiasts from Tashkent' produced a tube based on photo-conductivity and it was of double-sided construction (the optical image formed on one side of the mosaic and read by the scanning electron beam from the other). In 1937, McGee himself instigated EMI work to develop potentially viable photo-conductive tubes along such lines, contrary to his own later conclusions, but at the time, was designed to 'prove' that EMI's emitron was initially inspired by the work of Campbell Swinton.<sup>510</sup> Grabovsky and his team were a long way from fully developing their television system when their work was closed down, but even if their photo-conductive tube was poor, the core operating principle was probably sound, as confirmed by McGee.

Compared with McGee's claims on behalf of EMI, Sarnoff's claims on the matter concentrate on the system rather than just the pick-up tube. He said:

The system employed is known abroad as the Marconi-E.M.I. Television System, which is fundamentally based on the R.C.A. Television System first developed in the R.C.A. Laboratories in the United States. Under an exchange of patent licenses, this British company may use R.C.A. patents in England, and in turn, R.C.A. and its American licensees may use British patents in the United States.<sup>511</sup>

This statement does not enter into details but the expression 'fundamentally based on ...' is much closer to the contemporary written evidence. In his comments on the matter of originality, RCA's Zworykin was more specific:

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<sup>510</sup> Miller and Strange, "Images by the Photoconductive Effect".

<sup>511</sup> Abramson, *Zworykin*, 276, note 16.

EMI was building a television system for 240 lines with 25 pictures per second. The general system was very similar to ours, in fact it was almost an exact copy. The picture also compared favorably with our own.<sup>512</sup>

This statement was made about the system before EMI had adopted interlaced scanning. The lack of interlace can be deduced, as he refers to 240 lines and interlacing usually demands an odd number of lines.

Senior EMI television engineers, L F Broadway and W D Wright (optical specialist) visited the RCA television laboratories for an extended period in 1933/1934. Zworykin recalled this visit:

Two engineers, one of them Broadway, came over in 1933-4 in our laboratory for three months with the order to see all our work. I later mentioned this to Shoenberg. You know what he told me? He said that he couldn't get anything from RCA. It's all developed originally in Britain. I say how about Broadway and the others that were in my laboratory for three months? 'They are fools' he said, 'They didn't bring anything'. He was joking because Broadway was one of their best men.<sup>513</sup> Letters between Zworykin and Shoenberg indirectly confirm this visit,<sup>514</sup> and the other engineer involved, Wright, mentions the visit in his 1976 Shoenberg Memorial Lecture.<sup>515</sup>

In support of McGee and his stance on the EMI work, his colleague Broadway is quoted as saying:

I would think that we did a lot better in the technological area than RCA and Zworykin. McGee and EMI owe nothing to RCA and only in 1936 did the

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<sup>512</sup> Zworykin and Olessi, "Iconoscope".

<sup>513</sup> Abramson, *Zworykin*, 105.

<sup>514</sup> Correspondence between Shoenberg and Zworykin for the period 1933/1934 is incomplete but refer to visits to RCA Camden by EMI personnel and also Zworykin to EMI's factory in Hayes. RCA Archive.

<sup>515</sup> Wright, "Picture Quality", 7.



two companies sign an agreement for a complete exchange of patents and information. And that was quite a triumph because here was mighty RCA coming to EMI on an equal footing.<sup>516</sup>

This is not factually correct. There were patent agreements in force by virtue of the shared company history right from the days of HMV's work on television that became the EMI and ultimately the Marconi-EMI research. HMV and EMI only had agreements on receiving technology, but with the addition of MWTCO.'s transmission rights (which covered pick-ups), Marconi-EMI had full system entitlement by mid-1934. Perhaps Broadway was drawn to support his colleague McGee in his statements, or perhaps he was simply mistaken.

The view that supports the 1930s EMI television work as wholly original relies almost exclusively upon oral evidence by former research workers. The evidence to the contrary is largely circumstantial, with tantalising hints about co-operation in correspondence, known visits to RCA laboratories by EMI personnel at critical times in the development period, and an over-whelming similarity in the technologies employed, backed by considerable contrary oral records from members of the RCA research team. Whilst not a direct copy, the technology of the emitron was undisputedly very similar, if not identical, to that of the iconoscope, and EMI needed not only patent rights but proprietary information to successfully develop a version by the end of 1934. However, there is an alternative explanation to this position: that in terms of contemporary technology the iconoscope class of pick-up was not as difficult to reproduce as is usually accepted. I will now examine this hypothesis based upon the available information.

### **5.3.3 The 'straight-forward' iconoscope: an alternative resolution to the controversy of the emitron.**

My alternative hypothesis assumes that it was indeed possible to have developed the emitron solely from the bare outline of the patent information. The tube was relatively simple in terms of its basic principles of operation, even though some aspects of the practical tube never matched theoretical predictions, especially with

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<sup>516</sup> Norman, *The Story of British Television*, 105.

regard to the electro-optical sensitivity. By the early 1930s many laboratories around the world had the capability to make complex glassware and sophisticated glass/metal seals needed to make such a tube. The electron gun inherent to the tube's operation was not greatly different from that of a display CRT. Knowledge and experience gained in making receiving display CRTs would probably have been sufficient to make a suitable assembly, however, the construction of the mosaic would have been very difficult without knowing about the baking process (see Section 4.4.3). The associated electronics were complex, and this may have been one of the most difficult parts to design independently. If it was actually possible for any competent and skilled research group to make the iconoscope, there might have been other versions made in the very early 1930s at about the same time as the emitron. There is some evidence to support this from around the world, as I will now describe. The following companies, besides EMI, all made their own version of the iconoscope:

- Philadelphia Storage Battery Co. (USA). Earliest known date: 1934
- SAFAR (Società Anonima Fabbricazione Apparecchi Radiofonici) 'telepantoscope' (Italy). Earliest known date: 1934
- Leningrad Institute Telemechanics (USSR). Earliest known date: 1934.<sup>517</sup>
- Philips Natuurkundig Laboratorium (The Netherlands). Earliest known date: 1936
- Telefunken AG (Germany) Earliest known date: 1936<sup>518</sup>, perhaps earlier
- Hamamatsu Higher Technical College (Japan). Earliest known date: 1937(?)
- BTL. (Britain). Earliest known date: 1938

Figure 5.6 shows pictures of the tubes and pick-ups associated with these companies. Exact dates cannot be determined, but they are all from the mid to late 1930s. The SAFAR tube is unusual in that it used a mirror drum scanner to produce the vertical deflection. Philips and Telefunken were known to have purchased samples of RCA iconoscopes with the latter buying rights to the device. It is also known that Japanese scientist Prof. Kenjiro Takayanagi of the Hamamatsu Industrial High School spent

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<sup>517</sup> Dunaevskaya, Klimin, and Uralov, *Boris Vasilyevich Krusser*, 31-33.

<sup>518</sup> Burns, *Television*, 541.

some time at the RCA television research facility in 1934.<sup>519</sup> BTL, although fairly late in producing an iconoscope compared to the others, used a unique photocathode material and according to research by Baird historian Douglas Brown, was actually better than emitron in terms of its photo sensitivity.<sup>520</sup> As a major rival to RCA, Philco would also have had little direct information beyond the patent information. Without the knowledge of being able to legally make the device with a patent agreement in place, what would be the point in making them? Perhaps the motive could have been for comparison purposes with another technique or perhaps as an experimental base with a view to creating something better.

The existence of all of the above variants and versions might suggest that the iconoscope was not particularly difficult to construct for a suitably equipped and staffed laboratory. How much information transfer was needed beyond the basic patents is not obvious, but given that BTL, as Marconi-EMI's strongest competitor in the field, managed to create a superior version, it would seem that not much more information was needed. However it was at least six years later than RCA's initial work of 1932, in which time secondary sources of information could have been available through people moving from one company to another, or knowledge leakage via a common customer such as the BBC. From the known facts about the existence of iconoscope derivatives, it is possible, but still unlikely, that given a competent team of engineers and the necessary resources, a successful copy could have been made very early in the decade from just the patent information. My own experience of a similar, immediate post-war device, the image iconoscope, also suggests that a successful copy might have been possible, but only if some documentation and/or an example of the tube had been available.<sup>521</sup> Given the very early existence of the emitron, not long after the iconoscope, it is virtually certain that detailed information beyond the patent information passed from RCA to EMI.

Whilst the pick-up tube is the most obvious, and arguably the most difficult to master of the new all-electronic television technologies of the early 1930s, there

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<sup>519</sup> Abramson, *Zworykin*, 134.

<sup>520</sup> Brown, "Electronic Imaging".

<sup>521</sup> Marshall, "Solid State Image Iconoscope, Part 1".

were other important system factors shared between RCA and Marconi-EMI. These system level issues are significant and collectively probably more important than the iconoscope/emitron developments in understanding the two firms' industrial relationship, and it is these issues which I will consider next.

#### **5.3.4 Systems technology and standards**

Exactly how good technically a television system had to be to satisfy potential users was something that had never been addressed by the proponents of electro-mechanical techniques. The pioneers had produced television systems limited in performance by the technology of the late nineteenth century mechanical designs and the available radio spectrum space, rather than by examining what was actually needed by a viewer. Determining and writing a target specification had never been attempted for television until RCA began work in the very early 1930s to simulate the likely results using cinema and photographic technology. The work was carried out by a small team, managed by the then head of RCA's television research group, Elmer W Engstrom, who, in the very early 1930s, was actually senior to Zworykin, with the television laboratory informally known as the Zworykin/Engstrom group.<sup>522</sup> The extensive package of work was not published until late in 1933, in a series of papers authored by RCA engineers Engstrom, Ray D Kell and Zworykin. These papers, a set of three, are formally described as being the work of the RCA Victor Company Inc. of Camden New Jersey, and are the first known systematic study of human image perception in terms of technical parameters, whether as film, photography or television. The research consisted of lengthy practical trials conducted at the Camden facility and an example of one of the simulations is shown in Figure 5.7 illustrating the effects of constraining image resolution.

The papers reveal a wealth of in-depth studies relating to the number of lines, number of frames per second, viewing distances, image sizes, aspect ratio, brightness, contrast ratios, analysis of flicker effects, horizontal versus vertical resolution and many other salient factors. The goal of this methodical study was to determine the standards that a television system would have to achieve to be

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<sup>522</sup> Abramson, *Zworykin*, 115-117.

comparable to the cinema, albeit in a home setting.<sup>523</sup> Film technology, and specifically home movies, formed a frequent technical benchmark throughout these studies. Another group of papers published by the television group describe studies of ultra-short wave transmission, electron gun theory, transmitter techniques and domestic receiver technology.<sup>524</sup>

Amongst this wealth of technical information presented in great detail is another paper describing one of RCA's most significant technique: the flicker reducing/bandwidth limiting principle of interlacing (initially known within RCA as intermesh) which I described in Appendix 3.2, developed, according to RCA corporate history, by the firm's television research engineer, Randall C Ballard, with a patent applied for in July 1932. It was granted in Britain by November 1934 but not until 1939 in the United States, the delay being due to legal challenges.<sup>525</sup> The technique was certainly not new – its likely origins in the work of Sanabria in Section 3.3.1 – but Ballard, using CRT technology and electronic timing pulse generation, succeeded in making the technique work exceedingly well. With his more modest 2:1 scheme (compared to Sanabria's 3:1 system) the technique was used to effectively double the frame rate without increasing the scanning rate. This effectively doubled the theoretical resolution possible in RCA's television system without reducing the frame rate or doubling the bandwidth. EMI, via the Marconi-EMI relationship, had rights to use the technique. Given the prior art on interlacing, it is surprising that Ballard's patent was granted and that RCA gained exclusive rights to it. It was thus denied to BTL, despite the basic concept being an idea that Baird had patented as 'intercalated scanning' even before Sanabria. The technique was initially a difficult one to perfect when used for higher-definition, and RCA wasn't able to successfully demonstrate it until late in 1933.<sup>526</sup>

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<sup>523</sup> Engstrom, "A Study of Television Image Characteristics", 107-128.

<sup>524</sup> Maloff, "Theory of the Electron Gun"; Beers, "Description of Experimental Television Receivers"; Kell, "An Experimental Television System – Part II".

<sup>525</sup> Abramson, *Zworykin*, 117-118.

<sup>526</sup> *Ibid.*, 130.

EMI had done little, if any, fundamental work on the system specification aspects relating to the required image quality. As of 1932 its television research team was using vertical rasters, following the practice of Baird's electro-mechanical systems. By 1932, vertical rasters had been rejected by RCA, probably due to psycho-perceptual advantages, or perhaps because of the simple logic of having the lines in the direction of the longest dimension of the image. Furthermore, the RCA specialist in the field of human vision, Engstrom, recommended adopting cinema aspect ratios, 4:3 or 6:5, and this resulted in a 'landscape' format. Wright recalled that EMI was still using vertical rasters at the time of his visit with Broadway to the RCA laboratories in the autumn of 1933.<sup>527</sup> It was here too that Wright and Broadway saw working interlace for the first time.<sup>528</sup> EMI had been experimenting with an interlacing system based on a flawed optical technique but, upon the return of Wright and Broadway, moved to horizontal rasters and electronic interlacing along the lines that they had seen in the RCA laboratories. Formal rights to the interlace technology were effectively granted upon the formation of Marconi-EMI in March 1934.

Another fundamental principle discovered and adopted by RCA concerned an early appreciation of sampling theory, and how a television raster fundamentally limits resolution at right angles to the scan lines (or vertical resolution in the case of a horizontal raster). The investigation was carried out by Ray Kell of RCA, and the conclusion was drawn that there was no point in trying to equalise the number of horizontal pixels with the number of lines in an effort to produce square (actually round as scanned by an electron beam) pixels. The inherent vertical sampling process of a television raster limits the perceived vertical resolution compared to the continuous, un-sampled horizontal resolution. The sampling effect leads to a statistical probability that picture detail will fall between scan lines and not be registered as amplitude modulation.<sup>529</sup> The effective horizontal resolution can thus be reduced from its simple square pixel model value, reducing the required system

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<sup>527</sup> Wright, "Picture Quality".

<sup>528</sup> Wright, Letter to Zworykin. RCA Archive, Zworykin Collection, Trips and Conferences Series, England, 1929-1937 (Box 4, folder 2) Oct 12, 1933.

<sup>529</sup> Kell, Bedford and Fredendall, (1940), Determination of Optimum Number of Lines in Television Systems, *RCA Review*, Vol. 5, 8-30.

bandwidth quite significantly. This was not a patentable discovery, but the knowledge of its existence as a television phenomenon helped to relax transmitter and receiver specifications. In 1934, Kell estimated this figure to be about 0.7, and this was the figure incorporated into RCA's system specifications. The required television system bandwidth has a direct linear relationship to this value, and it represents a substantial reduction in the target bandwidth for a given scanning rate.<sup>530</sup>

Interlacing and the Kell factor combined resulted in a reduction of the required system bandwidth (the contemporary expression being 'maximum picture frequency') for a given scanning rate of some 3:1, reducing the figure to a third of that otherwise expected. The required scanning rates had been defined by Engstrom and his fellow researchers relating to the psycho-perceptual issues of television, but their system level targets were very ambitious for 1930s electronics. Without interlace and the insight of the Kell factor, the required system bandwidth would have been far too high for the electronics and wireless engineers to deliver without lengthy and costly developments. The number of lines and/or the frame rate would have had to be significantly reduced, and consequently the perceived picture quality would have been much lower.

I have singled out the above fundamental systems contributions made by RCA as being significant because they were of immediate use to EMI in creating its own television system in late 1933 to 1934. EMI did make its own significant advances in all-electronic television technology, but these did not occur until after 1934, and were more practical improvements than fundamental ideas. Examples are the circuit topology known as the long-tailed pair (patented in 1935), invented by EMI's leading electronics engineer, Alan Blumlein, which greatly simplified and enhanced wide-band circuit design;<sup>531</sup> his 'DC working', which stabilises the 'black' of a picture;<sup>532</sup> and a resonant energy recovering line scanning system, leading to much

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<sup>530</sup> Kell, Bedford and Trainer (1934) Experimental Television System - The Transmitter. *Proceedings of the IRE*, Vol. 22, 1248-1265.

<sup>531</sup> Alexander, *Alan Dower Blumlein*, 188-189.

<sup>532</sup> Burns, *British Television - The Formative Years*, 385.

greater power efficiency.<sup>533</sup> None of these techniques was vital to the establishment of a high quality television system, and RCA managed quite well without them in its own experimental systems.

Whilst the EMI and Marconi-EMI developments undoubtedly produced significant improvements, they were not necessary to create a viable CRT based all-electronic television system. By 1935, both companies had working all-electronic television systems from their own designs and manufacture. However, in Britain, Marconi-EMI allowed the impression to grow that their system was technically superior to that of RCA, based solely on the number of television lines used. According to the contemporary publicity, the British Marconi-EMI system with 405 lines was ahead of the American RCA system with 343 lines, which a closer examination of the technology reveals to be false.<sup>534</sup> I will now explore the competing television standards and explain why there was actually no real difference between the two, other than the headline number which was a useful marketing and propaganda tool for Marconi-EMI.

### **5.3.5 RCA 343 line, 60 field and Marconi-EMI 405, 50 field systems compared**

The number of lines is the instant ‘figure of merit’ which makes headlines, but engineers knew that the much more meaningful, but harder to grasp, ‘maximum picture frequency’ was a truer indication of the system capabilities.<sup>535</sup> RCA had chosen 343 lines in 1932 and Marconi-EMI adopted 405 lines in 1934, so the standards are not exactly contemporary in origin, but this is the comparison usually quoted, as RCA continued with 343 until 1936.<sup>536</sup>

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<sup>533</sup> Alexander, *Alan Dower Blumlein*, 131.

<sup>534</sup> “Television Comes to London”, *The Observer*, 1936. Reports that America will soon commence television trials by RCA using 343 lines, whilst in Britain 405 lines will be used by Marconi-EMI.

<sup>535</sup> R.C.A., *Television*. In this collection of papers, Engstrom’s paper, originally published in the *Proceedings of the Institute of Radio Engineers*, “Television Image Characteristics”, 107-148, he explores the optimal, yet practical, levels of image resolution and picture repetition rate, and how these are related to the ‘maximum picture frequency’ – the system bandwidth. See in particular 108.

<sup>536</sup> “First Field Tests in Television”, *New York Times*, 1935.



Appendix 5.3 compares the two systems, that the RCA 343 line system had a theoretical ‘maximum picture frequency’ (bandwidth) of 3.29 Mc/s, whereas the Marconi-EMI 405 line system occupied 3.58 Mc/s. These figures are purely theoretical, and in the contemporary practical systems, neither would have been able to reach these figures due to high frequency losses. It is their similarity which is important, as both companies would have faced the same practical limitations. The reasons why the RCA system’s bandwidth is only marginally lower than that of Marconi-EMI, despite the difference in the number of lines, lie in the number of pictures per second (25 frames for Marconi-EMI, 30 for RCA) and the difference in the aspect ratio (5:4 for Marconi-EMI and 4:3 for RCA). The difference in the number of pictures per second was dictated by the electricity mains supply frequency in use. In Britain this was commonly 50 Hz in the 1930s, whereas in the United States it was usually 60 Hz. Limited power supply smoothing when rectified to DC, interactions with AC lighting and hum pick-up, all directed engineers into using the mains frequency as their fundamental reference for frame rates, to avoid moving black bars and swaying pictures known as ‘hum bars’.

All-electronic television of the 1930s was thus ‘mains locked’, and with the available transmitter/receiver chain bandwidth virtually fixed by design limitations, the number of lines possible was mathematically related to the mains frequency. Even if the full theoretical picture resolution of either system could have been achieved from the pick-up systems, the contemporary transmitter and receiving systems could only manage a bandwidth of about 2.5 Mc/s, somewhat under the theoretical system figure of 3.58 Mc/s.<sup>537</sup> Furthermore, the electrical focus capability of domestic televisions would not have been able to resolve such fine detail. The rival claims, and the associated coverage in the technical and lay press, concerning which system was ‘best’, was another manifestation of the nationalistic and corporate claims concerning television. In the United States, the Radio Manufacturer’s Association instigated a move to a 441 line standard in January 1937, ending the 405 line ‘superiority’, but the ‘headline’ difference between 405 and 343 was (and remains) a

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<sup>537</sup> Ashbridge, “Television”, 31.

point of much confusion, as it is only one parameter determining a television system's overall quality.<sup>538</sup>

#### **5.4 Baird-Farnsworth: alternative television technologies and alternative commercial incentives.**

RCA's and Marconi-EMI's television complete television systems of late 1934 were the benchmark for all-electronic television, but BTL, enriched by the adoption of Farnsworth's technology of the image dissector in 1934, was a serious alternative. I have shown that Marconi-EMI had clear, long- to medium-term intentions of producing a system of 'wireless with pictures', using wide bandwidth high-power transmitters as a new form of broadcasting. It is less clear whether the financial backer of Baird-Farnsworth (Gaumont British Picture Corporation Ltd.), had the same primary aims as its core business was film, not wireless broadcasting nor wireless set manufacture. Whatever its commercial priorities, technically and commercially, Baird-Farnsworth was a threat to the hegemony of RCA and its television technology.

BTL was founded in 1929, after the demise of Baird's earlier enterprise, Television Ltd. It needed to raise capital and develop its technical strategy with urgency to catch the wave of enthusiasm for electro-mechanical television. The relatively new wireless sound broadcasting networks were one possible commercial model to exploit the technology of television, but it wasn't the only possibility, even if it was the most obvious. I have shown in Chapter 3 that all three of my case history companies had appreciated the other possibilities for commercialising television and BTL was in the same potential markets.<sup>539</sup> However, at least initially, the company's financial investors forced Baird to concentrate on the immediate target of a broadcast television system with its potentially large sales of consumer television sets. This soon foundered, and the company was touted for sale by its vice-chairman, Sydney Moseley, in the United States and in Britain. Great interest was shown by a diverse

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<sup>538</sup> Abramson, *Zworykin*, 253.

<sup>539</sup> Kamm and Baird, *John Logie Baird*. Some of Baird's many proposed uses for television were: Noctovision (a night/fog vision system), 81-82, Fast facsimile, 354-356, Telewriter, 135, Phonovision (television recorded on to gramophone records), 82-83.

number of American millionaires and business-men, but no controlling deals were concluded. Moseley negotiated a myriad of complex attempted sales of BTL as a going concern, culminating in a block purchase of controlling shares by the Gaumont British picture Corporation Ltd.<sup>540</sup> The purchase was not publicly announced until January 1932, but it began a period of sustained investment and a new emphasis on television linked to cinema interests.<sup>541</sup>

Gaumont British was under the control of the Ostrer brothers, Isidore and Mark, President and Chairman respectively. They had become interested in the development of television, and with a thaw in relations between the BBC and BTL, the prospects for commercialisation had improved. Coupled to Baird's success with large screen television, BTL was potentially a useful acquisition.<sup>542</sup> Before the purchase, for BTL to succeed in the fast moving development of television, speed to market to exploit sales of consumer television sets had been the dominant objective. This changed with the acquisition by Gaumont British, especially as word of private demonstrations and descriptions of the iconoscope-based all-electronic systems from the RCA-Marconi grouping began to appear during the early months of 1933. The technical quality of any new BTL offerings had to meet or exceed that of its rivals and the company did not have the new, all-electronic, television technology.

As with the original independent Baird companies, Farnsworth and his small company had immense investor pressure to achieve rapid results, and as I described in Section 4.6, he had a short period within the Philco organisation, effectively carrying out television research as part of a much larger concern. In the summer of 1933, fresh from his experiences with Philco, he was back with his own company, once again operating as an independent entity, and being pressured by his original backers (the San Francisco Community Chest, described in Section 4.5) for a return on their investment. With a staff of just two and trying to compete with RCA, his prospects appeared poor. Staging a working demonstration of his system, albeit

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<sup>540</sup> Moseley, *John Baird*, 201-202.

<sup>541</sup> Briggs, *The Golden Age of Wireless*, 517.

<sup>542</sup> *Ibid.*, 519.

under closed circuit conditions, became a priority in order to raise the company profile, to reassure existing investors and to potentially interest new ones. This requirement was satisfied with a ten day event at a public showcase of modern technology at the Franklin Institute in Philadelphia beginning on August 24<sup>th</sup> 1934.<sup>543</sup> The demonstration, according to contemporary reports, was a success, but exactly how good his system was at that time is hard to gauge. The New York Times appears to have been enthusiastic, reporting images of tennis players as ‘all being clearly seen by the audience in the other room’.<sup>544</sup> Whatever the standard achieved it was certainly all-electronic television and yet was, at least in terms of the pick-up, very different from the iconoscope-based system which RCA had still not shown in public demonstrations. In June 1934, Farnsworth had received communication from BTL Ltd., requesting demonstrations of his system in London. The Gaumont British Picture Corporation was ready to buy its way into all-electronic television technology.<sup>545</sup>

In the pursuit of pick-up picture fidelity, Farnsworth’s image dissector became the main technology of interest to BTL. The company had to embrace some form of all-electronic pick-up, which wasn’t an iconoscope, to be able to compete with Marconi-EMI. Despite Baird’s continued reluctance to become associated with an all-electronic apparatus, the board of BTL fully appreciated that in order to increase resolution and overall image quality they needed the Farnsworth technology, especially as public knowledge of the iconoscope pick-up and its capabilities began to appear in 1933.<sup>546</sup> The dissector pick-up was working reasonably well, given large amounts of light, and was available, at a high price. Farnsworth’s all-electronic pick-up technology cost BTL, in addition to royalties, a cash payment of \$50,000, but the move gave the firm much needed all-electronic pick-up.<sup>547</sup> It was an ideal pairing:

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<sup>543</sup> Stashower, *Boy Genius and the Mogul*, 200.

<sup>544</sup> “Tennis Stars”, *New York Times*, 1934.

<sup>545</sup> Abramson, *Zworykin*, 135.

<sup>546</sup> Shoenberg, Sarnoff Library Archive (1933), Letters, Zworykin Collection, Trips and Conferences Series, England, 1929-1937 (Box 4, folder 2). Sequence of letters between Shoenberg, the secretary of the IEE, P. F. Rowell and Zworykin concerning the latter’s forthcoming journal publication about ‘Television with Cathode Tubes’, dated Jun 17, Jul 21 and Aug 14, 21.

<sup>547</sup> Stashower, *Boy Genius and the Mogul*, 206.

BTL needed the all-electronic television expertise of Farnsworth's company; Farnsworth needed the investment offered by BTL and its shareholders

This was not the only linkage within the Baird-Farnsworth grouping. Neither company had specialist wide-bandwidth transmitter knowledge to create a delivery system. Even though cinema television became a major feature of the commercial objectives of the company, transmission by wireless to cinemas would be the only viable method of programme distribution. Land lines of the early 1930s were not capable of carrying the wideband signals required by high-definition all-electronic television for any significant distance, meaning that wireless distribution to a cinema chain would be the easiest method. To do this, specialist wideband transmitters and receivers had to be bought, or designed and built. Buying such equipment from the transmitter technology leaders, MWTCO., or RCA, would probably have not been possible, given the interests of those companies in television.

An alternative source of supply existed in the British engineering company, Metropolitan-Vickers, based in Manchester. They had the necessary high power valves and the capabilities to design and build wideband transmitters, having developed much of the needed technology for induction and dielectric radio frequency heating intended for industrial applications.<sup>548</sup> The Metropolitan-Vickers tetrode valve technology was unusual in being demountable, having a continually pumped vacuum.<sup>549</sup> This feature made the valves themselves repairable and led to lower running costs compared to the traditional 'pinched off' permanent vacuum types as used by MWTCO. and RCA. Furthermore, the transmitters did not rely on these firms' powerful patents relating to neutralisation of the more usual triode valves.<sup>550</sup>

The final member of the Baird-Farnsworth grouping, Fernseh AG, was an existing BTL partner and brought its intermediate film pick-up technology into the group. By

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<sup>548</sup> Dummelow, *Metropolitan-Vickers*, 136 and 139.

<sup>549</sup> Macnamara and Birkinshaw, "The London television service", 51.

<sup>550</sup> Moulton, "Electron Tube Circuits", Patent No. 1,938,664. This RCA patent describes neutralisation of high frequency triode valves using a feedback technique to prevent unstable self-oscillation of the transmitter and maximise undistorted circuit amplification.

using conventional film stock and film cameras as an intermediary, Fernseh could create a sensitive, high resolution pick-up and by reversing the idea, a large screen cinema projector. The technology was physically large, difficult to use, unreliable and under-developed, but it did work. Although formal commercial links with Fernseh AG had been severed, the technical collaboration continued, but with BTL developing its own British designed and made version of the technology. By late 1933, BTL had all the necessary technologies for a complete television system in development, either from their own laboratories or via their associates. With the Ostrer brothers effectively running BTL, the interests of Gaumont-British began to shape the direction of their system developments towards the cinema and away from, or at least in parallel with, direct-to-home 'wireless with pictures' broadcasting.

Commercially, television to the home continued as a BTL goal, but television to the cinema, a more difficult technical proposition, became much more important after the acquisition by Gaumont British. The term 'telecinema' has been used to describe this form of television, and to a cinema owner this new development promised to increase the popularity and range of cinema generally. The success of BTL's televising of the Derby to the London Metropole in 1932 and 1933 (see Section 3.5), along with earlier experiments and other contemporary work in Germany and the United States, suggested a new use for television beyond the notions of personal point-to-point communication and the 'wireless with pictures' model. There appeared to be a public audience that was prepared to pay for live events relayed to their local cinema. Although the 1932 image quality, as evaluated by the electro-mechanical television standards of the early 1930s, was excellent, questions about how good it really was in comparison to contemporary 35 mm motion pictures must have been asked. To reach a workable standard of reproduction, the picture quality had to improve dramatically, especially in terms of spatial resolution (picture detail) and frame rate (flicker). To do this BTL needed many more television scanning lines, higher brightness, lower flicker and regulatory permission for wireless distribution. The prospect of all-electronic television, with its high speed and resolution, was even more important to the proposed 'telecinema' industry than the nascent studio to home broadcast television industry.

By early 1934, BTL had been transformed from being a tiny company with only very limited electro-mechanical television technology at its disposal, to a transnational grouping with many television technologies to call on. Farnsworth provided the much needed all-electronic capabilities with his image dissector and his high-quality display CRTs. Fernseh AG had brought the intermediate film scanner technology, which was important to BTL in that at its heart was a high quality telecine machine making it a core technology for a company exploring the applications of television to the cinema industry. Above all else, in Gaumont British, BTL had found finance and stable backers willing to stay in the business for the long-term. Baird was no longer in control of his own company, a useful name in terms of publicity, but no longer providing the technological direction or invention. The grouping represented a serious rival to Marconi-RCA, overlapping technically, geographically and commercially. In a very short time frame, Gaumont British had assembled a technically very capable organisation with sound commercial backing and prospects.

## **5.5 Conclusions**

The initial development of all-electronic television technology as a complete system, ready for a 'wireless with pictures' public service, had become a genuine race by late 1934, but with no immediate time frame for deployment. The concept technology of both groups worked, and the major issues to be settled revolved around commercial and regulatory matters. The RCA-Marconi grouping technology was almost ready for deployment, but there were no immediate commercial prospects, despite the large sums of money already invested. It was known that the iconoscope pick-up could perform adequately well, display CRTs were sufficiently resolute, large and bright, wideband transmission was feasible, if very expensive over a large geographic area, and consumer receivers could be manufactured at a reasonable price. If the Baird-Farnsworth grouping, by contrast, was not quite ready with a technically viable system, it was almost in a position to deliver one, especially if that system was based on a model of wireless distribution of cinema films to the home.

The two groupings had rather different technologies, very different company size/resources and increasingly through the early 1930s, rather different end markets in mind. Both groups' technologies were viable as a means to create a public television service, and both were capable of longer-term developmental improvement. Both groups had a viable patent pool and both had links with German companies. As of 1934, either could 'win' the television race, but the choice would not be for the public to make: that decision would be for the broadcasters, governments and regulatory authorities.

The country of origin of the technology was something that could not be ignored, but perceptions could be shaped and modified. Marconi-EMI was successful in minimising the effect of BTL and press accusations about the origins of its technology, but BTL was even more successful in never letting such questions arise, probably because of the well-known name of Baird, and his direct association in the British public mind of his having 'invented' television. The emitron was almost certainly a direct derivative of the iconoscope. There were strong links between RCA, MWTCO. and EMI in terms of patent agreements, technical co-operation, commercial protectionism in their home markets, personal friendships and historical



roots. It is not surprising that a company such as Marconi-EMI should have been formed to facilitate patent pooling, confirm commercial rights and develop technical strengths. The duality of the Marconi-RCA group in terms of co-operation and rivalry at the same time can only be explained by both Marconi-EMI needing to defend its national identity in public while facilitating the partners' common commercial and technical goals.

In the United States, commercial questions of timing relative to economic recovery dominated plans for the likely introduction date of all-electronic television services. In Britain all of these economic factors also applied, but with an added complication of BBC, GPO and government priorities over funding for services and BBC worries about monopolies – its own in service provision, and those of the likely capital goods suppliers. In Germany, the corporatist economy in place after 1933 saw television as a useful propaganda tool to be implemented with national coverage, using whatever technologies were the most pragmatic. The position with regard to deployment did not change significantly for a year or more after 1933, with RCA and the FRC prevaricating in the United States, the BBC and GPO still pondering the technical and commercial options in Britain and the German government rolling out a television service with the most immediately pragmatic approach, with little concern about future system obsolescence.

## Chapter 5 Figures



**Figure 5.1**

**Francis Barraud's painting of Nipper listening to a gramophone.**

Picture source: Ostergaard, E  
<http://www.erikoest.dk/nipper.htm>  
Accessed 09/03/2008



**Figure 5.2**

**BBC Type 'A' Microphone.**

Picture source:  
Beckwith R,  
<http://www.btinternet.com/~roger.beckwith/bh/mics/axbt.htm>  
Accessed: 05/09/2008



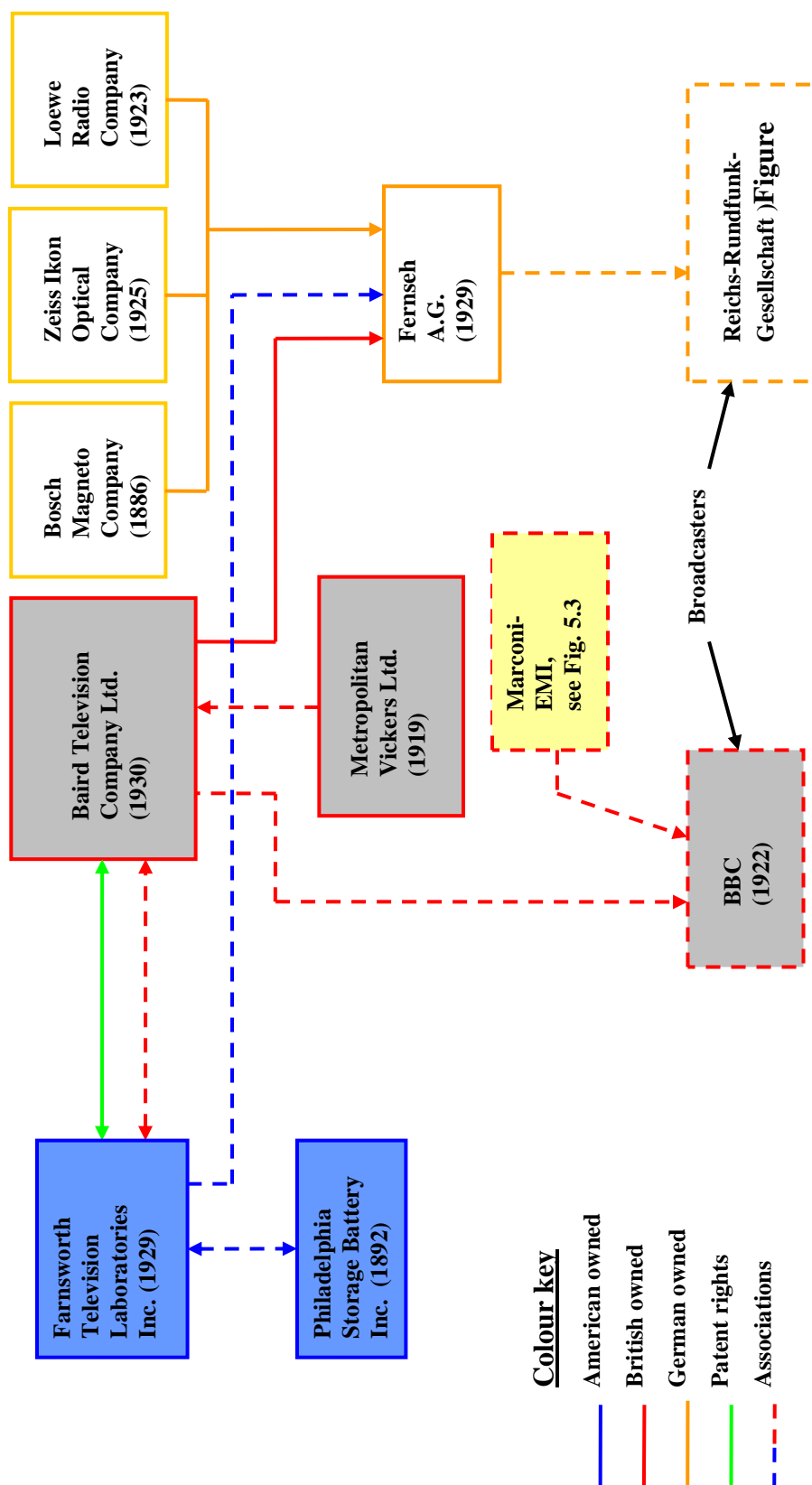
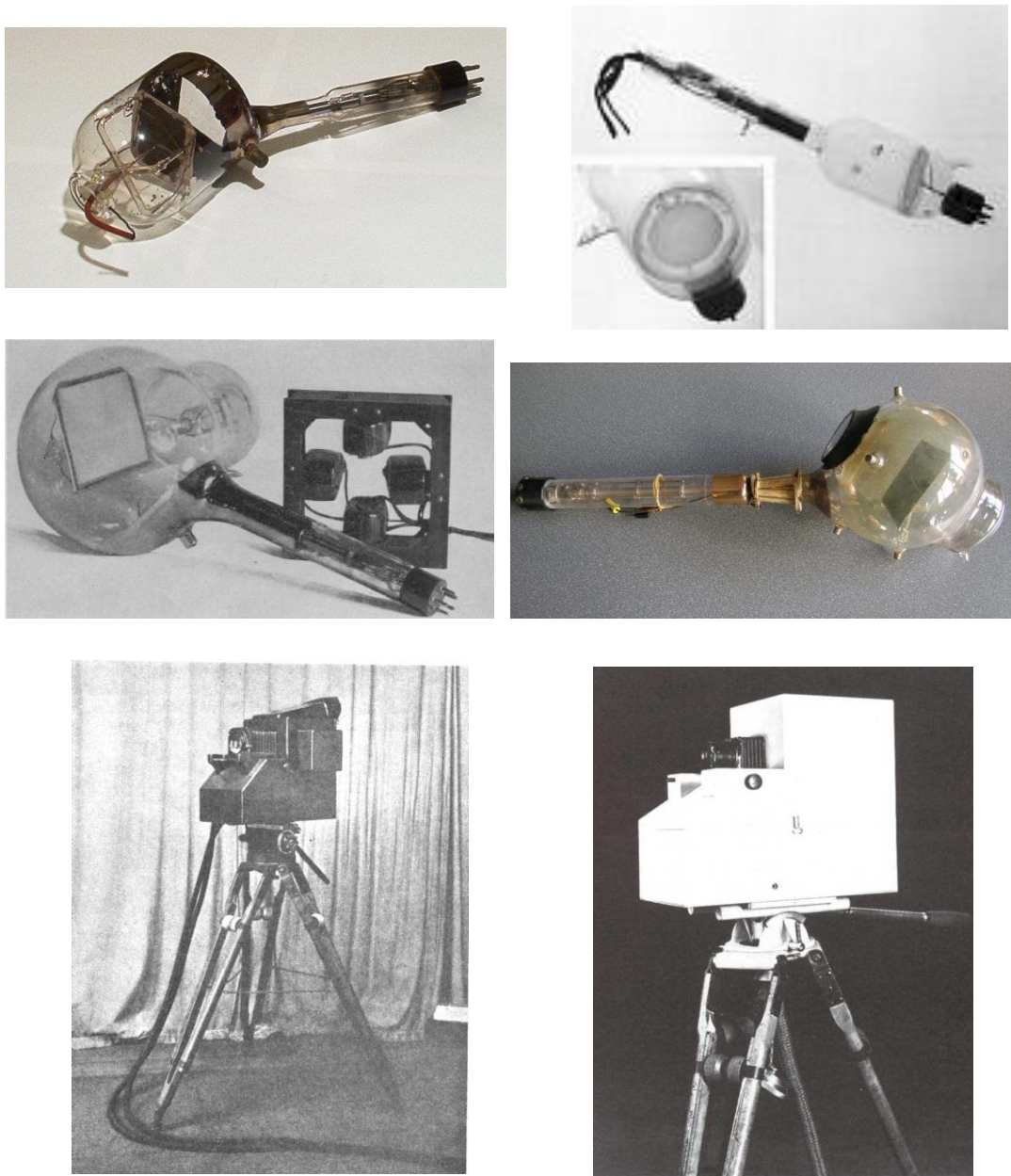


Figure 5.4 Company Linkages Between Farnsworth Television Laboratories Inc., Baird Television Company Ltd., Fernseh A.G. and Associates, as of 1934.

### Source notes for Figures 5.3 and 5.4:

Figures 5.3 and 5.4 have been created using multiple references from the following works and checked against other sources, including, where possible, contemporary magazines, newspapers and archive records.

Abramson, A., *The History of Television, 1880-1941*,  
Baker, W. J., *A History of the Marconi Company*,  
Burns, R. W., *John Logie Baird, Television Pioneer*, Burns, R. W., *Television: an International History of the Formative Years*,  
Fisher, D. E. and Fisher, M. J., *Tube - The Invention of Television*,  
Kamm, A. and Baird, M., *John Logie Baird - a life*,  
Magoun, A. B., *Television. The Life Story of a Technology*,  
Stashower, D., *The Boy Genius and the Mogul*,



**Figure 5.5 RCA iconoscopes and EMI emitrons.**

**5.5a. Top Left: RCA iconoscope 1932, image source:**

Flory, L <http://www.ominous-valve.com/images/ike100nr4.jpg> Accessed: 02/09/08

**5.5b. Top right: EMI emitron 1932, image source:**

National Museum of Science and Industry.

[http://www.scienceandsociety.co.uk/Pix/ENT/94/10250994\\_T.JPG](http://www.scienceandsociety.co.uk/Pix/ENT/94/10250994_T.JPG) Accessed: 02/09/08

**5.5c. Mid Left: RCA iconoscope 1934, image source:** Zworykin, V K, (1934)

The Iconoscope – A Modern Version of The Electric Eye 29, Fig. 10

**5.5d. Mid Right: Marconi-EMI emitron 1934, image source:**

SCRAN picture archive, Glasgow

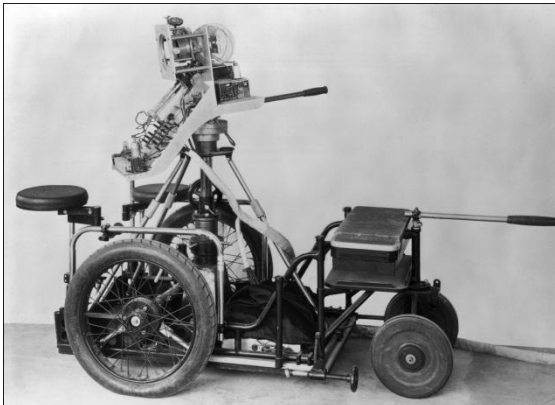
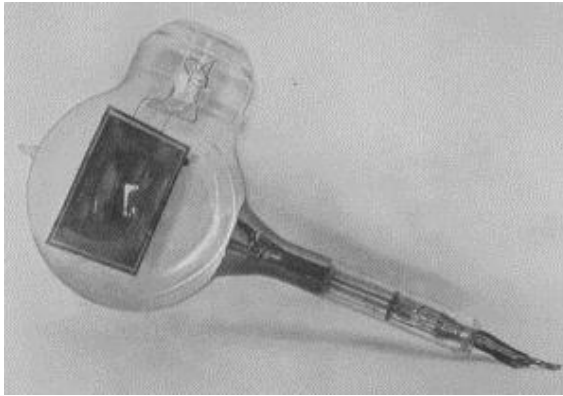
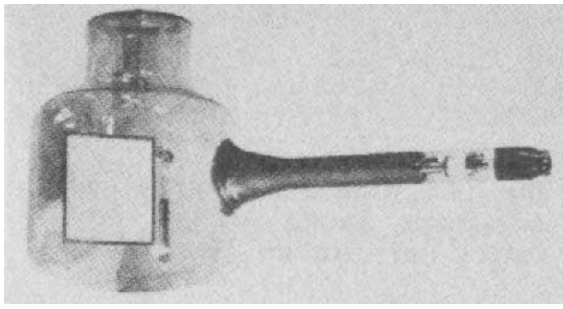
**5.5e. Bottom Left: RCA pick-up head 1934, image source:**

RCA (1936), Television. Collected Addresses and Papers on the Future of the New Art and Its Recent Technical Developments. 237

**5.5f. Bottom Right: EMI pick-up head 1934, image source:**

*Television and Shortwave World*, March 1936 133





**Figure 5.6a – 5.6f Other contemporary iconoscopes from around the world.**

**5.6a. Top Left: SAFAR (Italian) ‘telepantoscope’ iconoscope tube, 1936, image source:**

Early Television Museum, [http://www.earlytelevision.org/safar\\_studios.html](http://www.earlytelevision.org/safar_studios.html) Accessed 06/09/08

**5.6b. Top right: Telefunken (German) ‘fernseh kanon’ iconoscope pick-up, 1936 Olympic Games, image source: Early Television Museum**

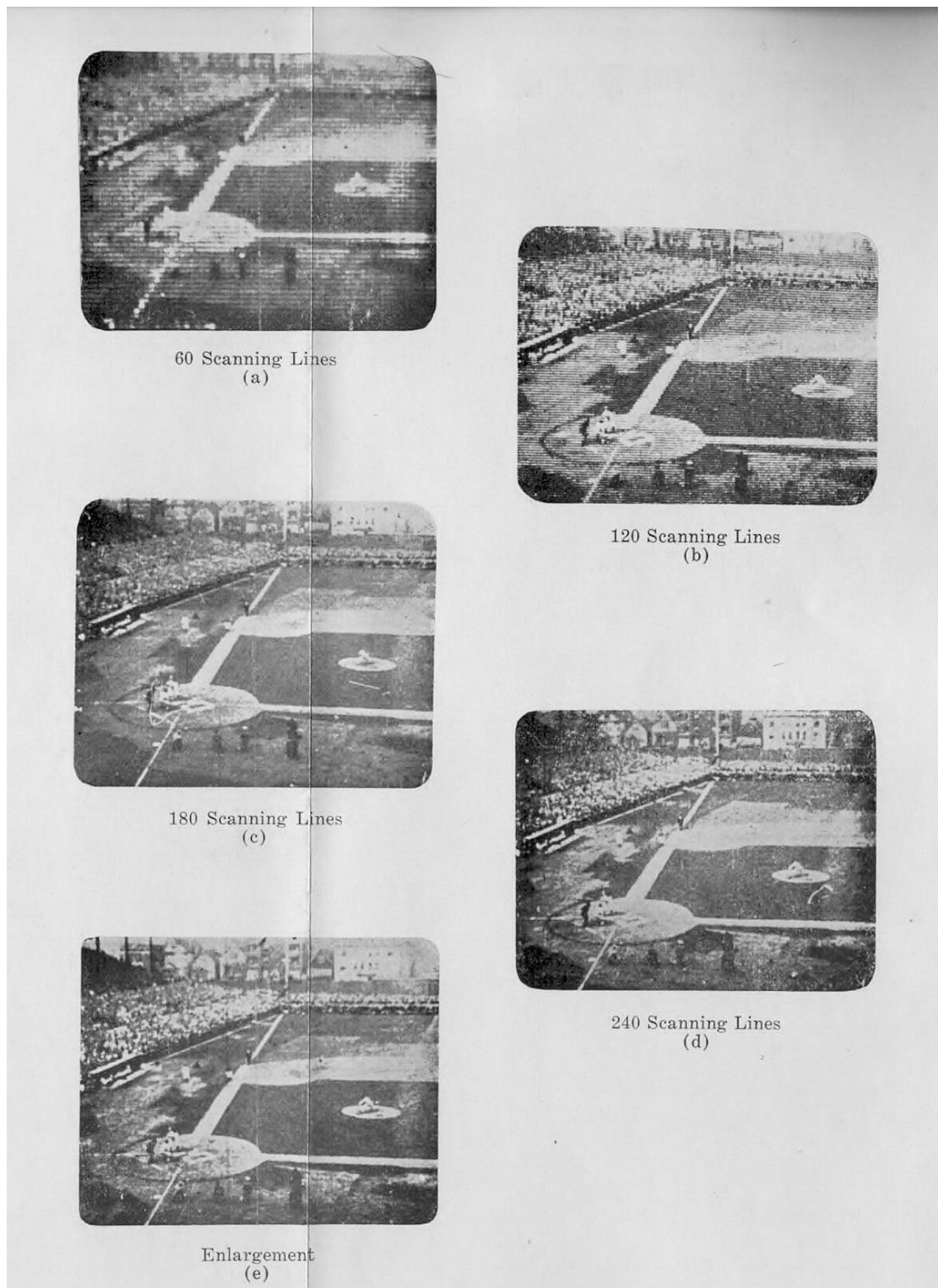
[http://www.earlytelevision.org/1936\\_olympics.html](http://www.earlytelevision.org/1936_olympics.html) Accessed 06/09/08

**5.6c. Mid Left: Philips (Netherlands) iconoscope tube, 1936, image source: The Cathode Ray Tube Site** <http://members.chello.nl/~h.dijkstra19/page4.html> Accessed: 29/08/08

**5.6d. Mid Right: Hamamatsu (Japanese) iconoscope pick-up 1937, image source: NHK (Japan Broadcasting Corporation),** <http://www.nhk.or.jp/str/aboutstr/evolution-of-tv-en/p06/index.html> Accessed: 11/09/08

**5.6e. Bottom Left: BTL (British) pick-up (cover removed) 1938, image source: Royal Commission on the Ancient and Historical Monuments of Scotland, SCRAN, ID 000-000-091-134-C**

**5.6f. Bottom Right: Soviet iconoscope tube by Pavel Smakov, 1937?, image source: Author, (2004) personal collection. Museum of Communications collection, St Petersburg.**



**Figure 5.7 Example of Engstrom's visual perception work with simulated television resolution standards.**

Picture source: R.C.A., *Television* , fold-out between 118-119



## ***Appendix 5.1.***

### ***Summary of Pre-eminent Television Companies, 1932-1934***

#### **In the United State of America:**

##### ***RCA***

The Radio Corporation of America was founded in 1919 as an amalgamation of American Marconi and General Electric's wireless interests. RCA was formed at the behest of the United States government in order to stimulate wireless development in the United States under national control. So far as American Marconi was concerned the creation of RCA amounted to forced nationalisation by the American government.<sup>551</sup> Numerous acquisitions and patent deals followed with AT&T, Westinghouse and others throughout the 1920s culminating with the purchase of the Victor Talking Machine Company in 1929 to form RCA-Victor, expanding the company's portfolio into phonographs and recorded music.<sup>552</sup> It was this move that secured 'Nipper' as a trademark for RCA. Television research interests came via the transfer of Westinghouse and GE interests in the fields of television and wireless in 1930.

##### ***Philadelphia Storage Battery Co.***

Founded in 1892 as the Helios Electric Company, adopting the name Philadelphia Storage Battery Company in 1906, it was commonly known simply as Philco. The company was the manufacturer of a huge range of wireless sets under the Philco name and was RCA's largest rival.<sup>553</sup> The interest of the company in television was mainly derived from the potential for home television receiver sales, but work was also being carried out on pick-ups and transmitters. For pick-up equipment Philco contracted Farnsworth's Television Laboratories Inc. to provide the necessary technology. Much of the impetus for Philco to be in television development came from its rivalry with RCA.<sup>554</sup>

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<sup>551</sup> Baker, *A History of the Marconi Company* 180-181.

<sup>552</sup> Gramophones were colloquially known as phonograms in North America.

<sup>553</sup> Burns, *Television* 366.

<sup>554</sup> Udelson, *Great Television Race* 120.

### ***Television Laboratories Inc.***

Founded in 1926 by Philo T Farnsworth to pursue his ideas for all-electronic television and based on a business model more akin to that of an idealised Thomas Edison than anything else.<sup>555</sup> The company remained a very small unit run as a family business funded by a local small bank. Approaches to GE and to RCA yielded some interest with RCA making a \$100,000 offer for the whole operation in 1931 that Farnsworth declined as it represented a loss on investment to date.<sup>556</sup> A two year contract with Philco signed in 1931 finally secured adequate resources to continue development of both pick-ups and receivers. In addition this gave Farnsworth access to Philco's transmitter work and receiver technology.

### **In Britain:**

#### ***EMI***

Electric and Musical Industries Ltd. was founded in 1931 following a merger of the Columbia Graphophone Company Ltd. and the Gramophone Company Ltd. Columbia had been an American company with a British offshoot but this became a wholly British owned company in 1922. Three years later the British Columbia Company bought out its former owner, the American Columbia Company to form once again a united organisation but this time British owned. Columbia also owned the famous HMV record label and industrial laboratories under the same name. Prior to the forming of EMI, RCA had purchased the Marconiphone Company and the M.O. Valve Company from Marconi's Wireless Telegraph Co. Ltd. in 1929 and merged them with the British Gramophone Company Ltd. Under the terms of the sale the Marconi Company was barred from trading in domestic broadcast receivers for a period of twenty years.<sup>557</sup> The British Gramophone Company became part of RCA when they purchased the Victor Talking Machine Company in 1929 and so RCA, by default, came to own significant shares in the new EMI Ltd.<sup>558</sup> EMI interest

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<sup>555</sup> Magoun, *Television* 27.

<sup>556</sup> Stashower, *Boy Genius and the Mogul* 181.

<sup>557</sup> Baker, *A History of the Marconi Company* 200.

<sup>558</sup> Burns, *Television* 432.

in television was derived from the HMV laboratories where zoned mechanical television had been their forte in the early 1930s.<sup>559</sup>

***Marconi's Wireless Telegraph Co. Ltd.***

Founded in 1897 as The Wireless Telegraph and Signal Company Ltd., this British company was arguably the leading wireless communications company for the first two decades of the twentieth century with diverse international interests and technologies. Guglielmo Marconi, the company founder, never showed much personal enthusiasm for television and the company never developed whole television systems by itself other than electro-mechanical placing its television interests with Marconi-EMI. Following the creation of RCA from American Marconi the British company gained extensive rights to American patents in many fields and as this agreement remained in force new patents in the field of all-electronic television were also available to use. Its expertise in wide bandwidth transmitters coupled with its patent rights and vast resources secured Marconi's place in the development of all-electronic television systems via Marconi-EMI Ltd.

***Baird Television Ltd.***

Baird Television Ltd. (BTL) was founded in April 1930 from an amalgamation of short lived earlier enterprises named Baird International Television Ltd. and the Baird Television Development Company Ltd. The founder, John Logie Baird, retained control of the technical direction of the company and this was towards ever better electro-mechanical television even if the receiver display might use CRTs. The company was quite well financed with a capital share value of some £825,000.<sup>560</sup> Compared to companies such as EMI and RCA pursuing all-electronic television at the earliest opportunity and employing high class research standard engineers and scientists, BTL relied on Baird himself with only relatively inexperienced research staff.<sup>561</sup>

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<sup>559</sup> In zoned electro-mechanical television systems the inherent limitations in the resolution achievable was offset by employing several systems side by side, merging the pictures together both at the pick-up and display ends of the chain.

<sup>560</sup> Burns, *Television*, 184.

<sup>561</sup> Burns, *John Logie Baird*, 150.

## **In Germany:**

### ***Fernseh A.G.***

Founded jointly in 1929 by four firms: Robert Bosch AG of Stuttgart, Loewe Radio GmbH of Berlin, Baird Television Ltd. of London and Zeiss Ikon AG of Dresden. It was formed specifically to develop television technology and products.

### ***Telefunken A.G.***

Founded in 1903 as the “Telefunken Society for Wireless Telefon”, a joint operation of Siemens & Halske (S & H) and the Allgemeine Elektrizitäts-Gesellschaft (General Electricity Company).<sup>562</sup> With its television work the company majored in electro-mechanical television technology but eventually used its rights to RCA patents to produce an ‘Ikonoskop-Kamera’ in 1934 derived from RCA designs.<sup>563</sup>

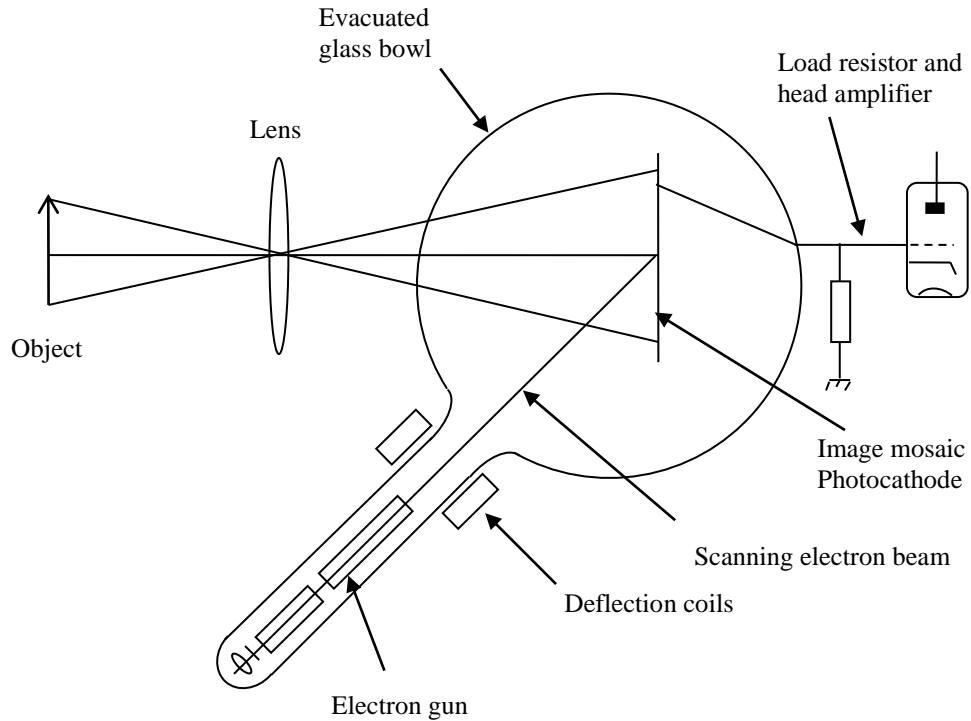
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<sup>562</sup> Baker, *A History of the Marconi Company*, 129 Telefunken translated literally is ‘spark at a distance’ revealing the early origins of this company from the days of spark transmitters in the first decade of the twentieth century.

<sup>563</sup> Udelson, *Great Television Race*, 110.

## **Appendix 5.2.**

### ***Principle of operation of the iconoscope***



**Figure 5.8 Iconoscope/emitron construction.**

With reference to Figure 5.8 above, the iconoscope tube consists of a highly evacuated glass bowl with an electron gun mounted at one end firing towards an inclined photocathode. The scene to be televised is optically focused normally on to the photocathode via the lens. The electron gun traces out a television raster on the photocathode firing a sequential stream of electrons. The photocathode mosaic consists of a thin sheet of mica with a deposit of silver-caesium on one side to act as a photocathode and the other side has a conducting layer of aluminium oxide. Incident light falling onto a point on the target causes local electron emission, stored as an electrical charge on the capacitor formed by the mica sheet and the conducting layer. As the electron beam scans the point on the target the charge is neutralised causing a current to flow in the photocathode load resistor. This is then amplified to form the video signal.

### Appendix 5.3

**Table 5.1 Theoretical Television Bandwidth Derivations – The 405 and 343 Line Systems Compared.**

	RCA 343/60	Marconi-EMI 405/50
No. lines (N)	343	405
No. fields (P)	60	50
Interlace (i)	2:1	2:1
Aspect ratio (A)	4:3	5:4
Assumed Kell factor (k)	0.7	0.7
Calculated B/W	3.29 Mc/s	3.58 Mc/s

Bandwidth (B/W) formula:

$$B/W = \frac{N^2 P A k}{i}$$

### Appendix 5.4 RCA and EMI Timelines Compared

**Sources consulted in the preparation of this timeline (over-page):**

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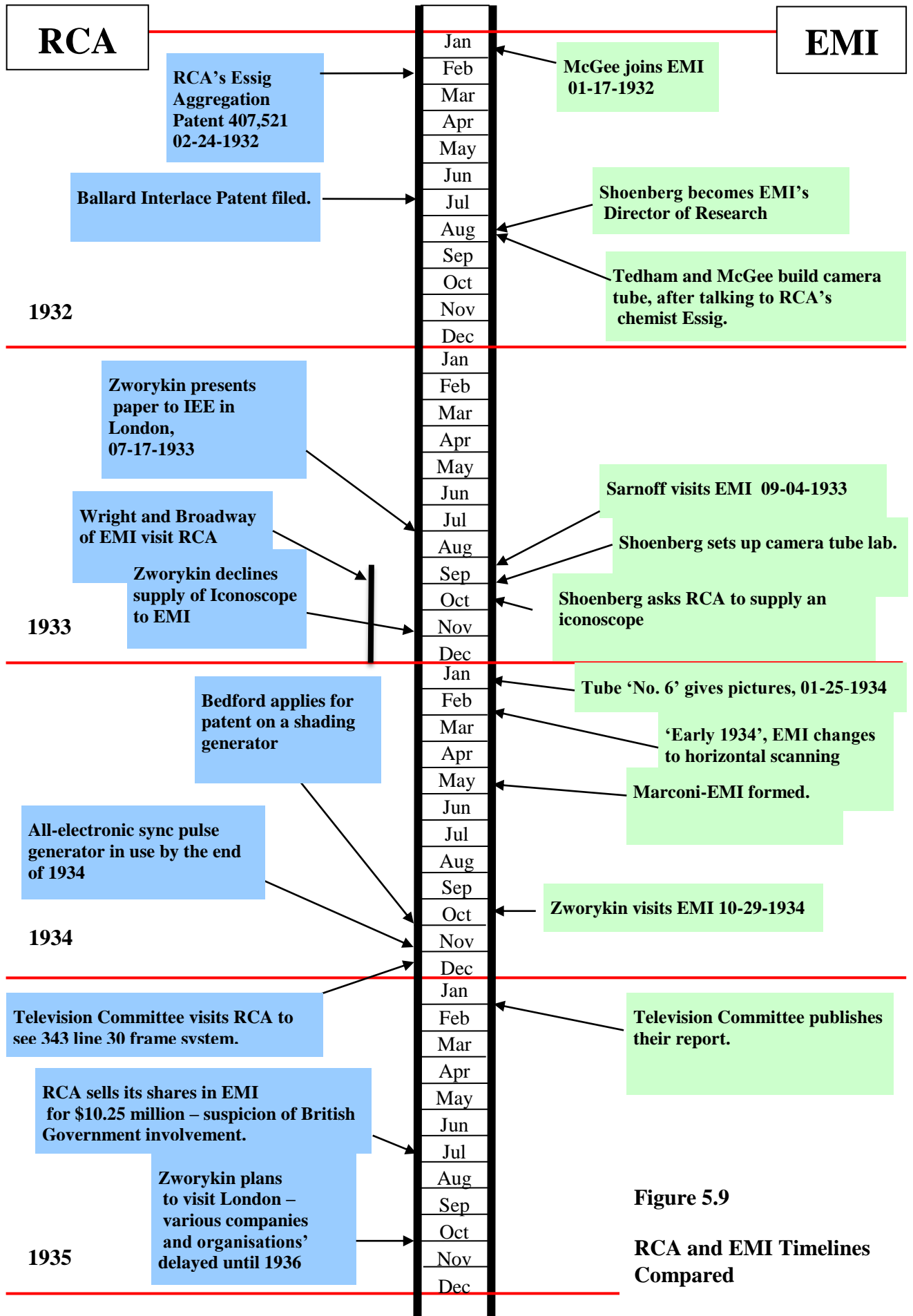


Figure 5.9

RCA and EMI Timelines Compared

## **Chapter 6.**

# **Monopoly and rivalry in the race for high-definition television**

### ***6.1 Introduction***

In Chapters 4 and 5, I examined the development of alternative technologies which could potentially offer a ‘better’ television: the high-definition, all-electronic, systems that had begun to emerge in corporate laboratories, primarily in the United States, Britain and Germany, with more limited activity in the USSR, France, Italy, the Netherlands and Japan. Commercially, at least for the wireless industry, a high-definition television system was unlikely to be a good proposition without major investment in much-improved technology, sufficient time to develop it and a credible source of programmes. Furthermore, the rapid deployment of high-definition television would have put conventional wireless sales at risk, and would not have been a good commercial strategy for deployment during the Great Depression. However, in Britain, the BBC bucked this thinking by launching an ambitious high-definition television service at the end of 1936. In this chapter, I will examine why and how the British established such a comprehensive television service so quickly in comparison to other countries, and also how the form of this service was shaped to reflect the BBC’s and the British Government’s plans for the future of television broadcasting.

I have described in Chapter 3, how, in the early 1930s, electro-mechanical television came into a limited form of service around the world; I then explained why it was not sustainable, and why it could not be developed as a new medium. The wireless industry knew that the Western public liked the idea of television, if it could be made ‘better’, but how could services be successfully introduced during the Great Depression? Whilst the USSR could achieve this with its command economy, companies based in other countries had to factor in market conditions and public acceptance. The USSR had a service in operation by late 1938 (using a complete, imported, RCA system), but only to public viewing rooms. No broadcaster in the United States began a regular public service of this type until after 1941. The



German Post Office began a 'medium-definition' service of 180 lines in early 1936, in time for the Berlin Olympics, although only to a small number of public viewing rooms. Other than the Olympic Games, German television was primarily based on the 'films to the home' model, although the principal viewing opportunity was not the home, but the viewing rooms. The British service of late 1936 was a high-definition, regular (daily) service with sets on sale to the public, and the transmission range potentially covered a population of ten million people. This service was primarily 'live', based firmly on the 'wireless with pictures' model, or 'direct television' as it was becoming known as by the mid-1930s.<sup>564</sup>

Why did the British invest so much money at a difficult economic time to achieve the goal, whilst American corporations held back? National pride, long-term commercial strategies, military uses, or a combination of all three, are all possible reasons for this expensive and (both commercially and technically) risky rush towards the opening of a high-definition television service, against a seemingly fixed deadline. I will show that whilst all three of these possibilities had some bearing on the rush to set up a service, the urgency was actually for a much more mundane reason: the preservation and extension of a monopoly – that of the BBC.

The British pre-war high-definition television service, in operation from 1936-1939, often known as the London Television Station – or just the London Station – demonstrated a working example of a new model of broadcasting to compete for the public's patronage with the 'talkies' at the cinema, albeit on a much smaller screen. The system produced quality pictures and sound, broadcast in a similar way to the popular wireless medium, but used a completely separate broadcasting infrastructure. CRT-based, high-definition television resulted in a much-improved technical performance, and the likely viability of television as a new medium was much increased. However, this came at great financial cost, diverting funds from the British rearmament programme and requiring sustained political and commercial enthusiasm, during the Great Depression. Despite this faith shown by the British

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<sup>564</sup> "Television in London and Berlin", *Popular Wireless and Television Times*. This article compares German and British television, confirming that Berlin is essentially film based to viewing halls for propaganda, with London as 'direct' television to the home.

Government, it was still unclear to most of the public what the new medium of television was meant to be for, but by the end of 1936 the television sets were there for the consumer to buy and use – although at a high price – giving the British television industry a world lead in most aspects of the technology, its marketing and in the new techniques needed for programme making.

The introduction of the London Television Service took the form of a competition between two rival companies: Marconi-EMI and BTL, each company having its own television system and installing its own proprietary equipment in the studios at Alexandra Palace in London. This competitive arrangement was created after discussions between the GPO, the BBC and the government, following the publication in January 1935 of a comprehensive report by the Television Committee, a body set up by the government to study television developments world-wide and to recommend policy. The forte of Marconi-EMI's system was live television transmissions from the studio using emitron cameras, which were well suited to live studio production work. BTL's best technology was its telecine, giving the company an excellent capability for televising films. Each system had its strengths and weaknesses, but the favourite to win the competition – according to the BBC and the GPO – was the Marconi-EMI system.

There was no inevitability about the final form of the station. The 'wireless with pictures' model won, and that was shaped largely by wireless interests, whereas the losing model of 'films to the home', could equally have emerged as the victor if the political and commercial situation had been different. BTL was effectively forced to compete on the 'wireless with pictures' form of television, rather than on its technical and commercial strength, 'films to the home'. Its failure to win the competition effectively entrenched the 'wireless with pictures' model under BBC control, forcing BTL to concentrate its future efforts on consumer television set manufacture, cinema television and military work.

I will begin by reviewing the political and commercial background to the possible deployment of television in those nations active in its development, examining the forces shaping the deployment of the 'better' CRT-based all-electronic television technology. The German and Soviet governments probably had the greatest desire to

be able to deploy television for propaganda purposes, but neither possessed the most mature technology. Companies in Britain and the United States had the most sophisticated and well developed all-electronic television technology, but there was no readily apparent political or commercial incentive to rapidly introduce an advanced all-electronic television service. Looking forward from early 1934, the most likely country to be able to introduce all-electronic CRT based television in a short time-frame was the United States, with RCA/NBC in the vanguard as potential whole-system providers. They possessed all of the necessary technology, having already developed it to a good prototype standard, although it was not in production.

I will then focus on the specifics of the British developments in high-definition television in 1934-1935, beginning with an examination of the possible reasons for the rapid British deployment of all-electronic television, and where the imperative for rapid deployment could have originated. Possible reasons might have been pressure from the wireless or cinema industries, and/or from a government sponsored industrial strategy. The use of television for military applications appears to have had only a minimal influence, although it remains a plausible linkage. My analysis will then turn towards the BBC's ambivalent relationship with the new medium of television, and how its views were changing as all-electronic television edged towards realisation and as the influence of its first Director General, John Reith, began to decline in the mid-1930s. I will then examine why the imperative emerged to establish a BBC television service before the end of 1936, before the expiry of the Corporation's first Royal Charter. My research explains the need for the rapid deployment of high-definition television in Britain in the context of the way that the BBC was initially set-up, how it was managed, the external forces competing with it, and attempts to break its monopoly on broadcasting in Britain.

In the next part of this chapter I will review the competition for the patronage of the BBC in its desire to establish high-definition television between Marconi-EMI and BTL. I will begin this section by examining the commercial factors affecting the speed of deployment, and to what extent rivalry between the two groupings outlined in Chapter 5 had an influence, especially with regard to company ownership and their preferred models of television broadcasting. The studio equipment installed by the two companies reflected their preferred broadcasting ideas, and I will review

how this can be seen in the equipment and technical specifications. I will also consider in this section how compatibility was engineered into the specifications such that domestic receivers could work with both standards.

As part of my analysis of the two systems, I will draw on my recent practical replication work of the two television standards, as presented in Appendix 6.2, which provides new information about the ‘failed’ BTL system. My researches in this are in the spirit of those of the Oldenburg Group, as I explained in Section 1.2.1. This work is useful because very few pictures taken from the television screen exist from the pre-World War II period. This approach has altered my own perception of the television systems on trial, the BTL pictures proving to be much more watchable than the technical specifications suggest. Furthermore, once the practical limitations of the Marconi-EMI system have been incorporated into the re-creation, the pictures from that system are not as good as might be expected.

In the final part of this chapter I will describe the events leading up to the setting up of the high-definition television service as a competition between the two rival systems, looking at the publicity and the build-up to the opening. This will show that the differences in the technical systems were minimised in advertising and that the programming was not the main draw. The competition was carefully presented to the public to be reassuring about the long-term stability of the service. Press enthusiasm was built-up with stories about presenters, sabotage and the name for a ‘viewer’, not the technology or the programming. I will then finish by examining the initial reaction of the British press and public to the new public television service.

## ***6.2 All-electronic television: the politics and commerce of a new global industry***

In terms of all-electronic television, American companies were in the vanguard of technical developments. The intensive television development programme of RCA had, by early 1934, produced a viable system covering all the major components of cameras, transmitters, telecine, antennas and domestic receiving equipment. Competitors such as the Philadelphia Storage Battery Co. (Philco) and the Farnsworth Television Company, had also created potentially viable systems. As I have described in Chapter 5, these American corporations were linked to British

companies such as MWTCO., EMI and BTL, which were working on high-definition television technologies in simultaneous collaboration and rivalry with their respective American associates. Companies in Germany, France, Italy, Japan, and research groups in the USSR, were also all able to claim, with some justification, technical success in the field of high-definition television, but they did not possess a credible whole system of all-electronic television.<sup>565</sup> In Britain and America, however, contemporary descriptions of the systems and the few surviving off-screen photographs (see Figure 4.9, for example) show that by 1934 all-electronic television had overtaken electro-mechanical television in almost all respects.<sup>566</sup> Only in the cost of consumer receivers did electro-mechanical televisions still have any real advantage.

Whilst probably not quite ready for commercial deployment, the technical quality of television had improved dramatically, and very quickly, making it a potentially serious threat in the coming decade to cinema, wireless, and even to certain forms of print media, such as picture magazines and photo journals. In the United States, and in Britain, vested commercial interests in existing media did not wish to see an early introduction of all-electronic television, and companies such as RCA fully appreciated the damage that it might do to sales of their own wireless receivers.<sup>567</sup> Media historian, Brian Winston, has described this as an example of ‘suppression’, whereby an existing industry prevents rapid deployment of a newer one.<sup>568</sup> Winston’s arguments largely concern commercialisation, which does not preclude spending on research and development relating to a newer technology. In the 1930s,

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<sup>565</sup> POST 33/4713 Parts 1 – 4. Un-published evidence to the Television Committee, Surveys of continental television activities. Post Office Archives.

<sup>566</sup> BTL had an electro-mechanical telecine that was actually superior to the Marconi-EMI all-electronic one based on iconoscope cameras. This was one of the very few examples in the 1930s of an electro-mechanical television device offering better technical performance than all-electronic. The iconoscope was unsuitable for telecine operations because of its need to ‘store’ a whole television frame and also its unpredictable image shading, exacerbated by sudden ‘cuts’ in typical film footage.

<sup>567</sup> Burns, *Television*, 486.

<sup>568</sup> Winston, *Media Technology and Society*, 111-114. The case is made that the forces of ‘suppression’ against television were strong in the United States but government needs overcame similar attitudes in Germany and in Britain.

RCA spent large amounts of money on television research and development, whilst simultaneously spending on improved wireless technology such as frequency modulation (FM).<sup>569</sup> Significant innovation and development during the Great Depression was common across many industries, anticipating improved trading conditions and demand for new products. This has been described as the ‘depression-induced accelerator’, and other examples in the 1930s ‘cluster’ include jet engines, radar and plastics.<sup>570</sup>

By late 1933, only RCA, in conjunction with its broadcasting subsidiary, NBC, could conceivably have produced a full all-electronic television service. By early 1935, other companies in Britain, the United States and Germany also possessed the total technical and manufacturing capability to create a viable system consisting of cameras, studios, transmitters, receivers, and the manufacturing base capable of designing and making all of these items, especially the volume production of television sets.<sup>571</sup> For potential television broadcasters from other countries without the indigenous corporate capabilities in all-electronic television, there was the option to purchase specific parts or complete systems, as happened in the case of the USSR (as I will describe later in this section), but this was the only example of such a sale before World War II. The major factors determining whether a high-definition television service could be started in the near term were largely political and commercial. There were no major technical barriers to deployment.

The commercial realities of the Great Depression suppressed corporate enthusiasm for high-definition television services in the three leading countries. They had that much in common, but there was one major difference in their situations: the structures of their national broadcasting organisations and of the politics behind them. In the United States, it was a government licensed system of private broadcasters, driven almost solely by commercial interests but regulated by the Federal Communications Commission (FCC), which was responsible for all the

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<sup>569</sup> Abramson, *Zworykin*, 134.

<sup>570</sup> Clark, Freeman, and Soete, “Long waves, inventions, and innovations”, 316.

<sup>571</sup> Report of the Television Committee 1935, Appendix III, Visits to the United States and Germany (unpublished part). Post Office Archives.

technical and regulatory issues relating to broadcasting. In Britain, the licence-funded BBC was the only indigenous broadcaster, and the GPO, as an agency of government, was in control of all broadcasting licensing and operation.<sup>572</sup> In Germany, the government had almost total and direct control of the airwaves as the new (and only) broadcaster, the Reichs-Rundfunk-Gesellschaft, was controlled by the propaganda ministry.

In Germany, the possibilities of television for propaganda purposes had attracted the attention of the National Socialists, and there was a political will to establish a network of television stations, which is illustrated by surviving plans for an extensive network of transmitting stations.<sup>573</sup> In terms of the actual technology of television, the Germans still lacked one key item: a viable all-electronic high-definition television camera, a development which, owing to shared patent rights between RCA and MWTCO., British companies had ready access to. Telefunken and Fernseh did gain access to the technology, although not simply by right. It was achieved by Telefunken and Fernseh purchasing the technology of the iconoscope, but it was not fully developed by German industry until the late 1930s. The Nazi government established a public television service in 1935, showing films to a number of public viewing rooms, but it was hastily expanded in the summer of 1936 to relay the Munich Olympic Games. This service operated on 180 lines (non-interlaced), and was not of high technical quality, suffering from flicker as well as being of only moderate resolution. Sir Frederic Williamson, of the GPO, who witnessed a demonstration in December 1935, commented that the service 'was not at all satisfactory', concluding:

If what I saw was representative, and there is no reason to think the contrary, it would appear that Germany generally is a good deal behind the present state of development in this country [Britain].<sup>574</sup>

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<sup>572</sup> Although the British Broadcasting Company had already asserted its political and editorial independence from government, underlined by its responses during the General Strike of 1926 and by the formation by Royal Charter of the British Broadcasting *Corporation* in 1927, it was (and still is) ultimately allowed autonomy by the goodwill of the government of the day.

<sup>573</sup> Burns, *Television*, 496.

<sup>574</sup> *Ibid.*, 498.

The development of television, despite the propaganda imperative, does not seem to have been a national priority, except perhaps briefly during the 1936 Olympic Games, with the journalists of the world watching and reporting. The three physically enormous Fernsehkanonen (television cannon) iconoscope cameras used (see Figure 5.6b) would have been clearly visible to the audiences in the stadium, and pictures were relayed to viewing rooms built specially for the athletes and journalists. There is confusion in existing literature about whether the then in general use 180 line television system was in sole service, or whether a 375 line interlaced format was utilised just for the local relays.<sup>575</sup> It has been claimed by German authors that up to 150,000 people saw the 1936 Olympics on television at 28 viewing rooms, but a figure of 100,000 was claimed in the official Olympic report.<sup>576</sup> The Olympic Games was unusual for German television in being ‘live’ material, or ‘direct television’. Most German programming was created on film, either made especially for the television service, or adapted from films made for the cinema. The film programmes were scanned by telecine machines at the Paul Nipkow Television Centre in Berlin, and then distributed by landlines to several transmitters operating in the ultra-short waveband.<sup>577</sup> Academic study to date has largely centred on the audiences and the politics of the service, with little attention paid to the technology and how it was shaped by Nazi requirements.<sup>578</sup> A considerable amount of the filmed material survives, preserved in a former East German archive, and the propaganda nature of the programming from these examples is clear (see Figure 6.1).<sup>579</sup> No television sets were on sale to the general public in Germany until 1939, the

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<sup>575</sup> Fisher, “The Olympic Media dossier, Berlin 1936”,

[http://www.terramedia.co.uk/media/change/olympic\\_games\\_1936.htm](http://www.terramedia.co.uk/media/change/olympic_games_1936.htm) Accessed 08/03/2011

<sup>576</sup> A contemporary official Olympic report: Limpert, “The XIth Olympic games, Berlin, 1936: official report”, 339. This estimates the viewing figures at 100,000 people from August 1 to 16 1937, with the number of viewing rooms being increased from 11 to 28 for the Games. Other sources suggest a figure around 150,000, but with no time frame specified. See: Eisner, Müller, and Spangenberg, “The early history of German Television”, 208.

<sup>577</sup> Burns, *Television*, 498.

<sup>578</sup> Uriccho, “Envisioning the Audience”; Eisner, Müller, and Spangenberg, “The early history of German Television”.

<sup>579</sup> Kloft, *Das Fernsehen unter dem Hakenkreuz; Television in Third Reich Germany*, Channel 4.



reception of television being restricted to the public viewing rooms and a few private sets in the homes of senior Nazis. As a largely ‘film to viewing room’ service, it is a concept which does not conform directly to either the ‘wireless with pictures’ or the ‘films to the home’ model, but neither does it represent the notion of ‘adding live television to the cinema’. It was a hybrid system, created for reasons of political and technical expediency, with technical standards which could be updated without affecting large numbers of consumer installations.

France also had an experimental 180 line service operating by November 1935, but this used electro-mechanical cameras. It was strictly experimental with no television sets for sale to the public. Without access to all-electronic cameras, political commitment and industrial involvement, French television was not a rival to the British, German and American endeavours. The French financial newspaper *Les Echos* commented in April 1935 that ‘It is useless to deny that France, so far as television is concerned, is behind. But this is not the fault of our engineers’.<sup>580</sup> The ‘fault’ was the way broadcasting was organised in 1930s France, as has been explained by media scholar, Donald R Browne.<sup>581</sup> His analysis of French broadcasting in the 1930s describes a conflict between private, state and political interests which effectively restricted growth and development. Such an environment was not favourable towards new innovations such as television.

The only other all-electronic, high-definition, regular public television service operating in the 1930s was that of the USSR, which began transmissions in February 1938, although it was not in full daily operation at that time. The service used RCA-supplied equipment throughout, from the studio, through transmission equipment and over the air to a small number of domestic/public receivers. RCA was pleased to receive such a large order at a time of difficult trading conditions, and it was also a useful trial production of its television technology without upsetting its own fragile domestic wireless business with promises about television that might be difficult to

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<sup>580</sup> POST 33/5143, Part 1 Post Office Archives Anon. ‘World Progress in television’. *Les Echos*, Apr 1 1935, anonymous translation by GPO staff.

<sup>581</sup> Browne, *Electronic media and industrialized nations*, 82-85. Describes the broadcast (primarily wireless) industry in 1930s France.

keep.<sup>582</sup> The system was supplied as part of a huge broadcast technology transfer, as Stalin required rapid and large improvements to the broadcasting infrastructure of the Soviet Union, well beyond its indigenous capabilities.

Although British companies had access to all the fundamental technologies of all-electronic television by late 1934, there appears to have been few reasons for the government or established manufacturers to force the technology forward; the wireless industry was certainly not keen to see it happen if sales of wireless sets would be adversely affected. Only the new companies, devoted solely to television, such as BTL and Scophony Ltd., had a commercial incentive to set up a television service immediately. However, Scophony did not possess a whole-system capability, and BTL, at that time, was still largely working with low- to medium-definition electro-mechanical television. So why did the British Government choose to begin developing a public high-definition television service in 1935 ahead of other nations, especially when compared to the United States, whose all-electronic television research was at a more advanced state and under similar economic conditions?<sup>583</sup>

### 6.3 The British imperative for a high-definition television service by 1936

#### **6.3.1 The likely prospects for British high-definition television in 1934**

My hypothesis is that there had to be non-commercial reasons for the British to establish a high-definition service as quickly as possible because the established wireless industry was certainly opposed to a rapid deployment of high-definition television. The *Times* reported in January 1935 the view of the wireless industry trade body, the Radio Manufacturers Association: ‘the time [is] not yet ripe for television to take the place of radio broadcasting’.<sup>584</sup> As well as the opposition of the wireless industry, worried about hitting wireless set sales, the economics of selling expensive consumer television sets were not good either. The projected price of

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<sup>582</sup> Magoun, “Adding Sight to Sound”. Explains the background to the supply of television equipment to the USSR by RCA.

<sup>583</sup> POST 33/4713 Parts 1 to 4 Appendix IIIA Un-published evidence to the Television Committee, American television status. Post Office Archives.

<sup>584</sup> “The Coming of Television”, *The Times*, 1935.

consumer CRT television sets by EMI in 1934 was about £100, an enormous sum even for a middle-class target purchaser. Isaac Shoenberg, Head of Research at EMI, predicted in 1934 that a sale of some 5,000 units could be realised by 1936. The wireless trade considered this to be very optimistic, given the economic situation and the price of the sets. Pursuing expensive advanced television research during a major world recession might have made some commercial sense, if that work resulted in a company having a new technology ready to sell as the recession eased, but attempting to sell a potentially damaging new development to existing markets too soon would not.

Furthermore, whilst the prototype all-electronic systems worked quite well, there were still some technical risks, especially those related to industry inexperience with the ultra-short wave-bands needed for transmission. None of the equipment, from studio cameras and transmitters to consumer television sets, had had much field testing, and the level of technical complexity far exceeded anything so far presented to the public as a wireless technology. Against these circumstances, for the newly formed companies solely focused on television, such as BTL and Scophony Ltd. there were strong pressures to establish some sort of service as soon as was practical to justify their existence and prospects to shareholders. For Marconi-EMI, this was not quite so clear-cut, as one of its parent companies, EMI Ltd., was also a major manufacturer of consumer wireless sets and gramophones. For all of the British companies, there was the problem that although the technology worked as demonstrable prototypes, it was not really ready for public use without further costly development.

Although the commercial prospects for adding pictures to wireless broadcasting in the mid-1930s were not promising, the cinema industry was beginning to show interest in using the new technology in its auditoriums, encouraged by the public response to demonstrations of low-definition electro-mechanical television by Sanabria and Baird, as I described in Sections 3.3.1 and 3.6, respectively. Whilst the cinema industry was wary of the harm television to the home might do in the longer term to its audiences, the companies probably saw a long-term potential opportunity to sell films for showing via the new medium transmitted to domestic receivers. Cinema interests in television grouped around the newly formed company of

Scophony Ltd., which I described in Section 3.6, and BTL. Of the two, BTL was by far the larger and more significant in 1934, having behind it the resources of the British Gaumont Picture Corporation, which had bought it out in 1933. This powerful backing enabled BTL to pursue cinema and broadcasting applications for television simultaneously. As a result of these interests, the commercial cinema industry in Britain was probably a much more significant influence on the development of television than in any other country, but in 1934, the actual technology was certainly not ready for deployment in mainstream cinema.

Although cinema and broadcasting interests were in the vanguard of the forces shaping the development of British high-definition television, another potential major force which might have advanced television development in the mid-1930s was the military. There has been a suspicion amongst several historians, largely following speculation after a ‘recollection’ by EMI graduate apprentice, Ian Orr-Ewing, about the rapid high-definition television development, that the needs of radar development was the major factor leading to the rapid deployment of all-electronic television technology in Britain in the 1930s. Orr-Ewing suggested that it was Lord Swinton, Secretary of State for Air, 1935-1938, who had encouraged the development of the British high-definition television system. Former BBC Foreign Correspondent, Leonard Miall, has investigated the claims, and he has concluded them to be un-founded.<sup>585</sup> It is, though, true that the British military had been interested in television since the demonstrations of electro-mechanical television by Baird in the 1920s. By the mid-1930s, military interest in the technology was concentrated in two areas:

1. General developments in electronics as a whole, accrued from television technology, notably those useful for radar work (referred to as radio direction finding (RDF) in Britain in the 1930s).
2. Actual uses for television, especially as a remote viewing and/or guidance system.

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<sup>585</sup> Miall, “The Golden Box”, 356; Hugill, *Global communications*, 186-188; Norman, *The Story of British Television*, 212; Hills, “British Military Television”, 100.

Both are plausible reasons for government interest in encouraging civilian development of television, especially as British rearmament gathered pace in the mid-1930s, but there is currently little evidence to support this. The issue of linkages between radar and television has been examined in a PhD thesis by Adrian Hills, investigating collaborative work between Baird, his companies and the military. Hills concluded that there were few provable links of this type before the late 1930s.<sup>586</sup>

Immediately prior to the beginning of the development of the London Television Station, the military position on television was largely one of ensuring that television transmitter masts did not become aerial obstructions, and that military radio frequencies were not commandeered or interfered with.<sup>587</sup> It was not until well after the decision to go ahead with the London Television Station that military enthusiasm for television began to grow, as radar development intensified. An example of this is the use of a consumer EMI television set as the main display device for radar experiments by National Physical Laboratory scientist-engineer, Robert Watson-Watt, and his team in the summer of 1936.<sup>588</sup> Other than a few specific instances such as this, the evidence for a link is circumstantial.

High-definition television and radar are not only contemporaneous inventions, they share many common technologies, people, companies, techniques and requirements. This is especially true of the British developments such as the Chain Home Radio Direction Finding, a radar system based on ultra-short wave transmission and reception that was very similar to the British high-definition television system in terms of operational frequencies and RF techniques.<sup>589</sup> Contemporary American and German radar technologies operated on much higher frequencies and did not have

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<sup>586</sup> Hills, "British Military Television", 301-303.

<sup>587</sup> POST 33/4713 Parts 1 to 4 Un-published military evidence to the Television Committee. Post Office Archives.

<sup>588</sup> Zimmerman, *Britain's Shield*, 127-128.

<sup>589</sup> The British Chain Home Radar system was designed to use frequencies in the 20-55 Mc/s range (in practice only 20-30 Mc/s was used), whereas the London Television Station operated between 35-39 Mc/s.

much commonality with their own television RF work. However, the nascent German television service of 1936 was placed under the command of the Reichsminister for Air, which might indicate some German military interest in the technology.<sup>590</sup>

Not only the RF technology but all early radar systems used CRT technology as the interpretive display. Many of the electronic techniques required were also shared between radar and television, such as low noise amplification of wide bandwidth signals and pulse processing circuits. Early work on CRTs for displays for radar in Britain used types made by American company Western Electric, but by the early 1930s the British radar researchers were using more advanced types procured from German company E Leybold-von Ardenne Lichterfelde. This foreign reliance worried the British Government.<sup>591</sup>

The potential uses for television in the military environment were diverse with applications including night vision, reconnaissance, remote piloting and message encryption.<sup>592</sup> There is evidence that the Admiralty was interested in the possible use of fog-penetrating infra-red television as an aid to navigation in the era of electro-mechanical television.<sup>593</sup> This was developed by Baird and was known as noctovision (night vision), but being based on electro-mechanical principles had little success, and failed to impress the Admiralty at a demonstration in 1929.<sup>594</sup> It is likely that this interest continued: the iconoscope class of pick-up had good infra-red (and also ultra-violet) response (so great that it proved troublesome in broadcasting applications altering the rendition of reds in the black-and-white images).<sup>595</sup> Other areas of military technology where there are recorded statements of interest, and

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<sup>590</sup> Burns, *Television*, 496.

<sup>591</sup> Abramson, *Zworykin*, 133.

<sup>592</sup> Hills, "British Military Television", 46-60.

<sup>593</sup> Burns, *Television*, 165-166.

<sup>594</sup> Hills, "British Military Television", 59.

<sup>595</sup> Black and white television and film requires a reasonably panchromatic response to colour. Non-panchromatic operation in early television typically led to dark reds appearing to be bright white, and bright blues almost black. The primary source evidence for this use is reviewed in: Miall, "The Golden Box", 356.

even issued contracts, are those of remote guidance of aircraft and surveillance applications. An early example of this is that EMI was approached by the Soviet Union to provide a miniaturised television camera for use on board an aircraft in February 1936, a request that was diplomatically declined.<sup>596</sup>

The military had needs for the volume production of CRTs for RDF and for oscillographs and for navigation aids, and there was also a requirement for powerful ultra-short wave transmitters for navigation systems and for RDF. Potential applications of television in aerial reconnaissance and the development of night vision devices are also all plausible and logical reasons for military interest. It is likely these incentives became an accelerant to television development later in the 1930s, but in late 1934, there were no immediate military imperatives to launch a high-definition service in Britain. With there being no commercially sound reason either, there had to be another explanation. I will now describe the actual reason for such a hurried introduction: the British Government's support of the BBC and its monopoly.

### **6.3.2 The BBC and its ambivalence towards television**

In Section 4.3.3, I described the BBC's stance with regard to electro-mechanical television, and its reluctance to offer Baird transmission facilities in the late 1920s. I explained Campbell Swinton's vociferous criticism of the BBC's involvement with electro-mechanical television, and how this coincided with internal engineering management opinion, resulting in an apparent hostility on the part of the BBC towards television in general. This attitude continued into the 1930s, despite the BBC reluctantly taking on responsibility for a more regular electro-mechanical 30 line television service in 1932. Television was not the only problem facing the BBC in the 1930s: a much more important problem was the expiry of its original charter in December 1936. The BBC had been formed as the British Broadcasting Company (not Corporation) in 1922, and operated then as a private monopoly, jointly owned by the six major British wireless companies, with MWTCO. in the vanguard. This arrangement came about following pressure from the GPO, and economic historian,

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<sup>596</sup> Ibid. and Burns, *John Logie Baird*, 330-331.

R H Coase, has explained that it was the GPO's wish to see just one broadcasting company in Britain – to avoid potential charges of partiality and to simplify administration.<sup>597</sup> The company became a Corporation by Royal Charter in 1926, with the company's general manager, John Reith, taking on the role of Director General. Reith was the principal architect of this change of status which enshrined the monopoly for a period of ten years.<sup>598</sup>

With its rapid growth and development of new technical facilities, the BBC quickly became a major cultural and political influence in British life, but the worthy tone of its output, as championed by the autocratic Reith, was not to everyone's taste. It faced considerable competition from the lighter commercial offerings transmitted from the continent, easily receivable even by domestic wireless sets of modest technical performance, especially in the south and east of England. Stations such as Radio Normandie and Radio Luxembourg openly sought British audiences, offering lighter forms of music and entertainment than the BBC.<sup>599</sup> The programmes were paid for by on-air advertising, something that was an anathema to the BBC ethos, but keenly embraced by potential advertisers. This advertising was largely controlled by the International Broadcasting Company (IBC), which booked space on the foreign stations such as Radio Normandie. The IBC was headed by a British businessman, Captain Leonard F Plugge, who repeatedly clashed with the BBC and the British Government over the international legality of foreign-based broadcasting to a home audience.<sup>600</sup> By the mid-1930s, the BBC was sufficiently concerned about audience desertion that it set up the Listener Research Department, which deduced that at worst (on Sunday afternoons), 60% of the British audience had deserted the BBC in favour of the commercial stations.<sup>601</sup> Whilst wireless was the primary target of those trying to break the monopoly, the founder of Radio Normandie, businessman, Fernand LeGrand, was keen to keep abreast of television developments and was in

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<sup>597</sup> Coase, *British Broadcasting*, 13-14.

<sup>598</sup> *Ibid.*, 46.

<sup>599</sup> Browne, "Radio Normandie", 5.

<sup>600</sup> *Ibid.*, 6.

<sup>601</sup> Street, "BBC Sunday policy", 161-162.



contact with Baird with regard to potential television transmission.<sup>602</sup> The monopoly of broadcasting enjoyed by the BBC was under threat.

The BBC's complex relationship with the British government in the pre-World War II period has been studied by many authors and historians.<sup>603</sup> The organisation's status as a politically even-handed company was tested during the period of the General Strike in 1926, but the BBC held its position of neutrality, effectively defying the government and remaining substantially impartial. With the granting of its Royal Charter in 1927, the BBC, then styled as a Corporation, had effectively secured a written guarantee of its independence – at least within limits. At one level, the Corporation was not under the direct control of the government of the day because it answered to the GPO and possessed its Royal Charter which defined its competencies and responsibilities. However, the government could still (at least in theory) have overridden any aspect of the BBC's activities, subject only to political agreement and public acceptance. The BBC, then, as now, exists in an ill-defined political environment with the Director General of the day holding considerable power – at least in principle. This was especially so in the time of Reith's early tenure of that post, when personal relationships between him and government ministers mattered greatly.

Reith was not the BBC, but he was, at least in the late 1920s and early 1930s, the face of the organisation so far as the government was concerned. His opinions on the issues of the day carried weight with the GPO and with the government, but increasingly through the 1930s Reith was progressively pushed to the margins until his controversial resignation in 1938. Reith did not favour the introduction of television, but his opposition to the new technology was passive (simply not appearing at events connected with its development), but overall this personal disdain probably counted for little, both within government and in the GPO. Given his direct access to companies and individuals working on developing television technology, he would have known that a better form than that offered by electro-

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<sup>602</sup> Browne, "Radio Normandie", 4.

<sup>603</sup> Milner, *Reith*, 122-149; Curran, *Power without Responsibility*, 114-121; Briggs, *The Golden Age of Wireless*, 392-398; Stuart, *The Reith Diaries*, 89.

mechanical methods was emerging, and that its early technical limitations would be overcome.

As led by Reith, the BBC saw its role as providing high-quality wireless services, free from commercial influence, and raising the intellectual expectations of the British public. Not supporting the rise of television would have damaged the future of 'his' organisation and that was something which he could never have condoned. The enthusiasm of others within the BBC for television ensured that the organisation would be at the forefront of television's deployment in Britain, with Reith passively allowing it to happen. His daughter, Marista Leishman, has described his attitude towards television thus:

The arrival of television, as inevitable as it was distasteful to John, was something from which he had to back off. Never at home with what he might consider the 'pleasure principle', he felt that television, in an unexamined way, suggested levity without demand.<sup>604</sup>

Reith's personal opinions about television were explored in two wide-ranging 1960s televised interviews, and his continual disdain for the medium is made clear in both.<sup>605</sup> There has also been a long standing suspicion, held by several writers and researchers, of a personal animosity between Baird and Reith (they attended the same engineering classes at Glasgow Technical College),<sup>606</sup> but this has now largely been dispelled by evidence from Leishman.<sup>607</sup> Reith's opposition to television did not stem from any personal animosity towards Baird, but from what he thought would be a shallow, vacuous medium that was likely to be a negative cultural influence on the British public, and possibly even a cause of moral corruption.<sup>608</sup>

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<sup>604</sup> Leishman, *Reith of the BBC*, 110.

<sup>605</sup> "Lord Reith" in *Face to Face*. Reith admits that '... was frightened of it from the start'; "Lord Reith" in *Lord Reith Looks Back*. Reith described television as '... a potential social menace of the first magnitude'.

<sup>606</sup> Baird, *Sermons Soap and Television*, 24-25. Baird describes his first tricky encounter with Reith.

<sup>607</sup> Leishman, *Reith of the BBC*, 111.

<sup>608</sup> Kamm and Baird, *John Logie Baird*, 110-11.

Reith, during his early period as Director General of the BBC from 1926 to the early 1930s, was able to shape the BBC's response to what he saw as the inevitable threat of television, but some time before he formally resigned in June 1938, his personal power had begun to wane. Until the mid-1930s, his own very strong opinions against television held sway, but other figures within the BBC were showing a lot more enthusiasm towards the idea. Noel Ashbridge, the BBC Chief Engineer, was an enthusiastic proponent of high-definition television. Following a visit to EMI in 1932, to see pictures of 120 lines at 25 frames/second displayed on a CRT, but sourced from a mechanical scanner, he said: 'Whatever defects there may be [in the picture] they represent a really remarkable achievement'.<sup>609</sup> Further demonstrations were witnessed in 1933 by Ashbridge, Admiral Sir Charles Carpendale (BBC Controller of Programmes), Harold Bishop (BBC engineer) and a large group of GPO representatives, presented at the EMI and BTL factories.<sup>610</sup> These demonstrations were inconclusive: EMI's results were judged to be superior, but using a very complicated system. Choosing which system to champion against a background of general opposition from Reith became a problem for the GPO and BBC engineering managements alike. Compounding these issues there was another potential problem – the threat of commercial television broadcasting operations from Marconi-EMI and/or BTL.

From 1932, BTL's Technical Director was ex-Chief Engineer of the BBC, Captain A G D West. He had already begun to steer the technical capabilities of the company towards higher television line and frame rates, moving away from Baird's low-definition electro-mechanical technology, by adopting Farnsworth's image dissector pick-up (as described in Section 4.5) in 1934 and more advanced German electro-mechanical techniques. In July 1933, BTL moved from its small Long Acre based facility to spacious new premises of 40,000 sq. ft. at the Crystal Palace in south London. Over the following year, the company established what was claimed to be the most extensive television facility in Europe. The elevated site boasted two 275 foot tall water towers, making the top 680 feet above sea level, ideal for carrying aerials for the highly directional ultra-short wave transmissions across the whole of

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<sup>609</sup> Ashbridge, N Report on television demonstration at EMI, Dec 6, 1936, BBC file T16/65.

<sup>610</sup> Burns, *John Logie Baird*, 292-293.

the Greater London area. This facility, with its high-power television transmitters designed by Metropolitan-Vickers, effectively gave BTL its own transmitting and broadcasting capability, as was noted by the American magazine, *Popular Mechanics*, with a headline declaring: 'London Station to Serve Ten Million People'.<sup>611</sup>

The Crystal Palace television studios and factory complex had three studios, the largest being 40 x 60 feet, and able to host ambitious television productions, hiring in artistes and performers as required. By early 1934, the BTL station was operating on a standard of 180 lines at 25 frames per second, and could source live pictures from a flying-spot scanner studio, a prototype intermediate film scanner system and a telecine machine. The station was experimental, but the facilities were excellent, with a new, more powerful, 10 kilowatt transmitter installed in December 1934 radiating from the very favourable site.<sup>612</sup> The GPO had been approached a year earlier and asked to transfer the company's licence to transmit on the ultra-short wave band from Long Acre to Crystal Palace. This had been agreed, but not before the GPO had asked the BBC's opinion. Reith signed a letter, written by the BBC's Chief Engineer, Noel Ashbridge, stating:

We have no objection to the transfer of the experimental stations ... to the Crystal Palace, provided that it is definitely understood that only research will be carried out, and that no series of programmes will be sent out which could be taken by listeners as being regular transmissions intended for public reception.<sup>613</sup>

Reith and Ashbridge were in effect re-stating the BBC monopoly, although whether they appreciated the BBC's own questionable legal position at that time with regard to television is not known. BTL had, by late 1934, a complete and working television broadcasting station at their disposal with only the lack of a full broadcasting licence from the GPO as a bar to beginning a full service.

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<sup>611</sup> "Electron camera shoots television images", *Popular Mechanics*.

<sup>612</sup> Kamm and Baird, *John Logie Baird*, 277.

<sup>613</sup> Reith, BBC Written Archive, T16/42/6 (Jul to Dec 1933). Letter from Reith to the Postmaster General.

Also by this date, Marconi-EMI had been experimenting with transmissions from the EMI factory in Hayes in Middlesex, but its transmissions were of much lower power, not from a favourable transmitting site, and still limited to electro-mechanical telecine, as its emitron camera was still in development.<sup>614</sup> BTL was ahead in the provision of a complete system, but Marconi-EMI had the prospect of the versatile emitron camera as a major advantage over BTL. Marconi-EMI could be confident of its technology, as RCA had already reached a good standard of performance with the iconoscope and the emitron was, effectively, the same invention. This, in turn, would have been a reassurance to the BBC and GPO that Marconi-EMI was not embarking upon an overly-ambitious programme of technical development: the technology was known to work.

### **6.3.3 The Television Committee and the imperative to achieve control of British television by the BBC**

Technically, by early 1934, all-electronic television was developing very quickly, with BTL and EMI demanding that the GPO and BBC should actively consider the future of television broadcasting in Britain in the form of new services. Even the reluctant Reith had to consider how the Corporation should respond to such requests, review which company's technology it ought to adopt, and whether the commercialisation of a television service could be avoided. On March 15<sup>th</sup> 1934 Reith wrote to the Postmaster General, Sir Kingsley Wood, proposing a conference 'between some of your people and some of ours to discuss the future arrangements for the handling of television'.<sup>615</sup> A conference was arranged for April 5<sup>th</sup> 1934 and was held at GPO premises in London. The attendees, F W Philips (Assistant Secretary), J W Wissenden (Administrative) and Colonel A S Angwin (Assistant Engineer-in-Chief) from the GPO, plus Carpendale and Ashbridge from the BBC, examined a number of general questions, including:<sup>616</sup>

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<sup>614</sup> Burns, *Television*, 465-466.

<sup>615</sup> Reith, J F W, Letter to Sir Kingsley Wood, Mar 15, 1934. BBC File T16/42. BBC Written Archives.

<sup>616</sup> Notes on 'Conference at General Post Office, Apr 5, 1934', Minute POST 33/4682. Post Office Archives.

1. The method of financing a public television service
2. The use of such a service for news items and plays
3. The relative merits of some of the systems available including those of the EMI, BTL, A C Cossor Ltd. and Scophony Ltd.
4. The arrangements necessary to prevent one group of manufacturers obtaining a monopoly of the supply of receiving sets
5. The possible use of film television to serve a chain of cinemas

It was agreed that a committee should be set up to advise the Postmaster General on all aspects of television, resulting in Wood forming the Television Committee, the first meeting to be in May 1934.

The appointment of the Television Committee to look into the whole question of the future of television in Britain was announced in the House of Commons in May 1934. It was clear to the BBC and the GPO that television, if it was to develop beyond the by then commercially failing electro-mechanical systems, was approaching a major change in technology, and that it should be managed to avoid problems with conflicts over technical standards, available wavelengths and responsible administrative bodies. The committee comprised representatives of the GPO, the BBC, Department of Scientific and Industrial Research (DSIR) and industry. It had as its principal term of reference:

To consider the development of Television and to advise the Postmaster General on the relative merits of the several systems and on the conditions under which any public service of Television should be provided.<sup>617</sup>

In effect, this was a review of television technology and possible organisational models throughout the world. The committee, reporting to the Postmaster General, consisted of:

Lord Selsdon (committee chairman, former Postmaster General and Privy Counsellor)

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<sup>617</sup> Report of the Television Committee 1935, Cmd. 4793, 4.

Sir John Cadman (committee vice chairman, Chairman, Anglo Persian Oil Company)

Vice-Admiral Sir Charles Carpendale (Controller, BBC)

Mr Noel Ashbridge (Chief Engineer, BBC)

Mr O F Brown (Department of Scientific and Industrial Research)

Mr F W Phillips (Assistant Secretary, GPO)

Colonel A S Angwin (Assistant Engineer in Chief, GPO)

Mr J Varley Roberts (committee secretary, GPO)

The final report produced by the committee was relatively brief, but this belies the contemporary importance of it, and the extensive national and international research that was undertaken to produce it. The evidence taken by the committee, and the transcripts of interviews with leading figures (both national and international), were never published, as the participants had been promised complete confidentiality. Fact-finding visits to Germany and the United States, alongside extensive investigations in Britain, produced in-depth evidence from thirty-eight witnesses at a cost of £965. An early conclusion by the committee was that ‘No low-definition system of television should be adopted for a regular public service’, ‘high-definition’ was defined as ‘not less than 240 lines and 25 pictures per second’.<sup>618</sup>

The large volume of unpublished evidence and appendices presents a detailed record of the global state of television development in 1934-1935 in terms of technology, commerce and politics.<sup>619</sup> Leading industry figures such as Sarnoff of RCA, Shoenberg (head of research at the recently formed Marconi-EMI) and Reith of the BBC were all invited to confidentially offer their opinions on the technical, commercial and political development of television in the short to medium term. Most witnesses appear to be cautious about the readiness of the technology, both technically and commercially, but all, even Reith believed that a high-definition television service could be created, even if its place in broadcasting was not fully defined. Sarnoff affirmed his belief that the time was not right to begin a television

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<sup>618</sup> Ibid., 9. Para. 26 forbids ‘low-definition’, and para. 28 defines ‘high-definition’.

<sup>619</sup> Unpublished evidence to the Television Committee POST 33/4713 Parts 1 to 4. Post Office Archives.

service in the United States, not just because of potential damage to the wireless industry, but also owing to the cost of setting up the necessary quantity of stations in such a large country.<sup>620</sup> Sarnoff used this latter reason in public to justify RCA's prevarication in setting up a fully functional high-definition television service, reflecting the needs of the American model of broadcasting based upon network affiliation to achieve national coverage.<sup>621</sup> Constructing a national television service for the geographically much smaller Britain presented far fewer challenges.

In Britain, the reasoning was very different, the BBC, GPO and the British Government had a pressing reason to launch a high-definition television service: the extension and preservation of the BBC monopoly. Hand written notes (possibly by Wood) in the margins of the fourth draft of the report state that the BBC Charter would expire on December 31<sup>st</sup> 1936, and that any high-definition television service should be running before this time to avoid public arguments and discussion about who should run television services in Britain.<sup>622</sup> Internal committee correspondence between Wood, Selsdon and government legal advisors noted that the legality of transmission of any form of television by the BBC had never been confirmed, and that, in the opinion of the Solicitor General, it was beyond the terms of its existing Charter.<sup>623</sup> Other internal correspondence notes the hostility of the press (and the public) towards the BBC, and suggests that there could be strong opposition to the BBC being designated as the operator of such a high-profile television service.<sup>624</sup> The committee envisaged that eventually there would be stations in most major cities in Britain, but there was pressure building from the GPO to complete at least the first part of a British high-definition television service (the London Television Station)

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<sup>620</sup> Report of the Television Committee, Cmd. 4793 January 1935 Appendix III, Visits to the United States and Germany (unpublished part). Post Office Archives.

<sup>621</sup> R.C.A., *Television* 1-5, 4. Record of David Sarnoff's statement to the Annual Meeting of RCA Stockholders, New York City, May 7, 1935, explaining RCA's position on television.

<sup>622</sup> Unpublished evidence to the Television Committee POST 33/4713 Part 3. Note in the fourth draft of the report on 27. Post Office Archives.

<sup>623</sup> Unpublished correspondence to the Television Committee POST 33/4713 Parts 1 to 4. Post Office Archives.

<sup>624</sup> 'Television – Press opposition to the choice of B.B.C' POST 33/4713. Anonymous, loose typed document reporting on press opinions and articles. Post Office Archives.



before the BBC Charter renewal date, in order to avoid exposing the possible legal and political difficulties during the charter renewal process – a process which was already under-way.

Alongside the Television Committee, another, more important inquiry was also about to report: the Ullswater Committee. This body had been charged with looking at the whole question of the BBC charter renewal, due by the end of 1936, but the future of television was beyond its remit. This aspect of the BBC's future had been left solely to the Television Committee to examine. The BBC was under considerable political pressure during the preparations for charter renewal and the outcome was not a foregone conclusion. The unpopularity of the BBC was manifesting itself not only in criticism of the Corporation itself, but in attacks on Reith. The *Daily Express* reported that at Question Time in Parliament, MPs from all parties were agreed that: 'The new charter must not be a licence for Sir John Reith to enjoy another ten years of what he's been pleased to call "Monopoly under God". Above all, he must not be allowed to rule his subjects like a dictator'.<sup>625</sup> The wider concerns of the Ullswater Committee had to be considered by the Television Committee with regard to how television might fit into a new overall scheme for broadcasting in Britain.

The initial discussions by the British Government about the report of the Television Committee were conducted by means of internal memorandums and letters between Wood (Postmaster General) and Neville Chamberlain (Chancellor of the Exchequer). Both were enthusiastic about setting up a high-definition television service as soon as was practicable, and ensuring that the BBC had control of it.<sup>626</sup> The Television Committee report declined to comment on what kind of programmes should be produced, and the government does not seem to have had any proposals on this topic either. The report concluded that this would be a matter for the BBC, and although advertising was to be prohibited, commercially sponsored programmes were not

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<sup>625</sup> Milner, *Reith the BBC Years*, 219-220.

<sup>626</sup> Correspondence between Chamberlain and Wood relating to the Television Committee POST 33/4713 Part 4. Post Office Archives.

ruled out. This latter point was never revealed to the public, but it was noted that this provision was already in line with the BBC's existing charter.<sup>627</sup>

Chamberlain, as Chancellor, was at great pains to establish a firm financial footing for the setting up of the London Television Station. Rearmament had begun, resulting in constrained government finances, and television broadcasting was not a priority. The projected cost of setting up the London Television Station was £180,000, and against a new overall settlement of BBC funding, it was agreed that the government should provide half and the BBC the other. At substantial cost and some political risk, the government had ensured that the BBC would seamlessly and without public debate assume control of television in the United Kingdom. There was one complication: both Marconi-EMI and BTL had been invited by the GPO to run the television service, each with its own television system, alternating, for a trial period, on a weekly basis.

## ***6.4 The rivals in the duel for British high-definition television: Marconi-EMI and BTL***

### **6.4.1 Planning for the British high-definition television service**

By early 1935, the financial, political and technical way was clear to establish a high-definition television service for London and the Home Counties, under the control of the BBC, to be opened before the end of 1936, before the end of the first BBC charter. The BBC had made sure that its monopoly of broadcasting would continue and extend into all-electronic high-definition television, whilst keeping the competing companies at arm's length. For the nascent television industry the time-scale was very short, given the prototype nature of the technology of the studio facilities, transmitters, antennas and domestic receiving equipment.

It was a closed competition: the government had effectively decided on the competitors, citing the fact that none of the other companies considered, Scophony Ltd., A C Cossor Ltd., and Loewe Ltd. (associated with the German company of the

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<sup>627</sup> Wood, (Postmaster General) Cabinet papers. Broadcast Television Service. Memorandum. C.P.14(35) Not dated. POST 33/4713 Part 4. Post Office Archives.

same name), had complete systems available.<sup>628</sup> The Chancellor expressed his concern about the closed nature of the two-way competition between Marconi-EMI and BTL. Writing to Wood, he said: 'I presume you are satisfied that if the scheme were publicly criticised in Parliament or elsewhere on this ground, there is an adequate answer'.<sup>629</sup> He expected to be questioned by the Opposition about this, and had to be convinced that the legal position was sound. Clement Attlee, Leader of the Opposition, did indeed raise this issue in Parliament, but appears to have been satisfied with Chamberlain's responses.<sup>630</sup>

The Report of the Television Committee and its unpublished appendices offer no military arguments to support the case for a high-definition television station; neither is the subject raised in the papers presented to the Cabinet by the Postmaster General.<sup>631</sup> The Cabinet agreed to set up a high-definition television service, initially serving London and the Home Counties along the lines proposed by the Television Committee. It was to be a two-headed competition to find out which of the two selected best systems (as judged by the Television Committee) would prove to be superior. The competition would be between Marconi-EMI with an interlaced 405 line system and BTL with a 240 line non-interlaced system. The BTL system only just met the criteria for 'high-definition', as specified by the Television Committee, and it is likely that the minimum was set after discussions with BTL as to what it could achieve, although it should be noted that at the time of the committee's investigations, Marconi-EMI was working with a 240 line interlaced television standard.<sup>632</sup> It is likely that the Government took the view that BTL, with its direct

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<sup>628</sup> Report of the Television Committee 1935 Unpublished part – Appendix IV, Description of television systems. Post Office Archives.

<sup>629</sup> Correspondence between Chamberlain and Wood relating to the Television Committee POST 33/4713 Part 4. Post Office Archives.

<sup>630</sup> Unpublished written answer by Chamberlain to Clement Attlee relating to competition questions in Parliament. POST 33/4713 Part 4. Post Office Archives.

<sup>631</sup> Wood, (Postmaster General) Cabinet papers. Broadcast Television Service. Memorandum. C.P.14(35) Not dated. POST 33/4713 Part 4. Post Office Archives.

<sup>632</sup> Report of the Television Committee 1935 Appendix IV, Description of Television systems examined by the committee in Britain – Marconi-EMI (unpublished part). Post Office Archives.

connections to Baird – the name most closely associated with television in Britain – had to be given a chance to compete. Ashbridge was enthusiastic to give EMI an unfettered opportunity to work with the Corporation, leading Reith to caution the GPO against this, insisting that both firms should be given opportunities.<sup>633</sup> If it had been denied a chance to compete, BTL might have used its existing Crystal Palace television station as a direct challenge to the intended BBC television monopoly.

BTL, with Baird as its public face, helped emphasise the national credentials of the company compared to the transnational ones of Marconi-EMI with RCA. The closeness of that relationship is underlined by the appearance of RCA's lead television engineer, Zworykin, in a promotional film, prior to its opening, about the station made by the BBC. In this film, *Television Comes to London*, Zworykin is shown looking out over the Alexandra Palace Park and is presented as 'the inventor of the television camera', in a segment describing the details of the Marconi-EMI system.<sup>634</sup> The film is even-handed in its coverage of the systems, with the Zworykin segment being balanced by shots of Baird, describing him as 'the British television pioneer', side-stepping the fact that he was no longer in control of BTL. The technical issues of the two systems are not addressed in the film, other than as a neutral presentation of both company's equipment with much fanfare and enthusiasm for both. The emphasis is firmly on the BBC and its part in the building of the London Station.

The choice by Marconi-EMI to use 405 lines, 25 frame interlaced, as their system has usually been presented as 'brave' or 'courageous' in secondary literature.<sup>635</sup> Whilst there were huge technical difficulties with a very tight deadline to meet, Shoenberg would have been confident of the outcome, at least from an engineering perspective. In Section 5.3.1, I compared the RCA 343 line 30 frame interlaced system with the Marconi-EMI 405 line, 25 frame, interlaced system, showing them

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Although the document refers to 240 lines, the format was 243 lines, a number amenable to interlaced working.

<sup>633</sup> Wood, letter to Sir John Reith, May 22, 1933 BBC Archive, file T16/42. BBC Written Archives.

<sup>634</sup> Bower, "Television Comes to London".

<sup>635</sup> Burns, *Television*, 366; Alexander, *Alan Dower Blumlein*, 160.

to be almost identical in terms of line frequency and video bandwidth – the two most significant technical parameters of a television system. Knowing that the 343 line system worked well, and that the iconoscope cameras were showing excellent results at the RCA laboratories, Shoenberg, and also the Television Committee, would have had considerable confidence in the success of the 405 line system. In essence, the 405 line system was RCA's 343 line system adapted for use in a 50 c/s mains electrical environment.

The elegant technique of interlace, as perfected by RCA engineers, resulted in a huge technical advantage over BTL with regard to flicker perception, although probably not in overall system picture resolution as I have shown in Section 5.3.4 and in Appendix 6.2. Support for this view is also found in Douglas Brown's PhD thesis on BTL, where a technical comparison is presented.<sup>636</sup> The differences in the potential picture quality are not as marked as the difference in the number of lines suggests. The relatively poor focus of domestic television sets, the restricted transmission bandwidth and the difficulty in maintaining the interlacing system of the Marconi-EMI picture all reduced actual image quality presented in the home of the viewer. Evidence of this is confirmed by my replication work recreating how images would probably have appeared, which is presented in Appendix 6.2.

Once the decision to proceed with the London Television Station had been taken by the Cabinet, the manufacturers of the studio and transmitter equipment, and of domestic receivers, could begin their task of designing and building the technical facilities and consumer receivers for the project. In addition, the BBC had to find suitable premises and start the modification of buildings and facilities to be suitable for the operation of the actual station. The Television Committee itself was reformed as the Television Advisory Committee (TAC), with Cadman replaced by Sir Frank Smith of the DSIR, who also chaired the newly formed Technical Sub-committee (TSC). The TSC was responsible for the technical specifications of the London Television Station, taking evidence from the competing companies, the GPO, the BBC and television set manufacturers.

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<sup>636</sup> Brown, "Electronic Imaging", 167-176.

One of the tasks of the TSC was to ensure that the two rival systems had as large a base of commonality as possible, so that domestic television receivers could be built to receive both standards on one set without any significant changes. Table 6.1 shows that there was considerable commonality in the systems, despite the large difference in the number of scanning lines (240 and 405). The costs associated with this dual standard working for domestic sets would largely have been incurred only at the development stage, as just the switching of a few adjustments were needed with a minimal number of extra components. The sound system was identical and a shared item, as were the vision and sound transmission characteristics, and the transmission antennas. The only large technical differences were in the horizontal frequency (the line rate) caused by the difference in the number of lines, and the fact that the Marconi-EMI system used the RCA system of interlace. This gave a strong advantage to that system in terms of bandwidth efficiency and flicker performance; a head start in the trial, as was well understood at the time.<sup>637</sup>

The differences at the studio end of the system were much more significant. The pick-up devices, in the form of cameras, were hugely different, with the BTL system having several techniques to offer, whilst Marconi-EMI had just the one: the emitron camera. The vision transmitters, whilst technically completely different, operated on the same frequencies and modulation standards. Marconi-EMI's telecine, an emitron, camera simply pointed at an adapted cinema projector, was its weakest technology. Apart from the problem of pick-up tube reliability and its use in telecine, the technology of the emitron was sound and the cameras were relatively sensitive, very portable, adaptable and fairly easy to use. In comparison, BTL had three 'live' pick-up techniques to offer, one of which was based on German technology, one on American technology and one on Baird's own older method of flying-spot scanning. BTL's telecine system was derived from the German technology. The three types were:

1. Spotlight scanner. This utilised photocells in a darkened booth with the subject to be televised illuminated by a bright spot of light sweeping across

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<sup>637</sup> Report of the Television Committee 1935 Appendix IV, Description of Television systems examined by the committee in Britain – Marconi-EMI (unpublished part). Post Office Archives.

the scene synchronised to the television rate. This was a faster and improved version of the 30 line mirror drum flying-spot scanner derived from Baird's earlier electro-mechanical television work.

2. Intermediate film scanner (see Figure 6.6). This was a high-speed variant of the Nipkow disc scanner whose technology came from Fernseh AG of Germany. The scene to be televised was photographed using a conventional 35 mm film camera, modified to use 35 mm stock split longitudinally to 17.5 mm width for reasons of economy. The exposed film was then fed to a rapid developing and fixing system, producing images which could then be scanned whilst still wet by a high speed Nipkow scanner. The Nipkow discs were of small size and run at high speed, delivering relatively high resolutions if the illumination was sufficient. The special discs only provided horizontal scanning, as the vertical scan was accomplished by the continuous passage of the film. Television by this method was strictly never 'live', as the developing and fixing took about a minute. The sound was also recorded on the film in order to maintain synchronism with the pictures. The processing involved using sodium cyanide for fast fixing and the machine was considered to be very dangerous. The camera was fixed in its own bay with glass walls to look out of, and it could only pan and tilt. Breakdowns were frequent. Picture and sound quality were invariably poor.
3. Electron camera - Farnsworth's image dissector, BTL's answer to the emitron. Its lack of sensitivity and unreliability meant that it was hard to use requiring huge amounts of light. It never delivered pictures of the quality achieved in the United States, but it was relatively small and portable, and compared favourably to the emitron in this respect.

In December 1936, a report was prepared by the BBC's Director of Television, Gerald Cock, describing the Corporation's experiences with the equipment provided by both companies. Whilst generally praising all aspects of the Marconi-EMI system, he entered into a detailed and scathing review of the BTL equipment, of which he said:

Alterations in apparatus were constantly taking place. Breakdowns, with little or no warning, and, even more serious, sudden, unexpected, and abnormal

distortions are a frequent experience. In such cases, it is difficult and embarrassing to make a decision to close down, since there is always the possibility that faults may be corrected within a short time. This inevitably leads to criticism of television by those who may only have observed it in adverse conditions.<sup>638</sup>

The only BTL item that was superior to the Marconi-EMI version was the telecine machine, which used the same type of high speed Nipkow disc as BTL's intermediate film system. This machine produced a picture quality from film which was superior in quality to the emitron based-telecine, and was reliable in its operation, although it suffered from poor maintenance standards from BTL.<sup>639</sup> Cock goes on to suggest that its 'contribution to programmes is limited by the present restricted use of 35 mm film'. He may have been suggesting that the BBC had been blocked by the cinema industry in the use of standard cinema film material, although this is not confirmed by other sources. Why BTL, owned by the Gaumont British Picture Corporation, would also have barred its own material for use on its own system is also unclear – perhaps a general bar was put in place precisely to prevent Gaumont British from benefiting. Plans to use film more may be implicit in the aspect ratio chosen for the BTL television standard of 4:3 which matched that of normal 35 mm film (see Appendix 6.1). Marconi-EMI, using an aspect ratio of 5:4, made the best compromise use of a typical round CRT display area without being completely square at 1:1.

An existing building was chosen to house the studios, transmitters and administrative offices at the Alexandra Palace in north London. Built as a northern 'mirror' to the Crystal Palace in south London, the Victorian 'people's palace' had found a new use as the home of British television. At 306 feet above sea level, the building looks south out over London and has commanding height over the Home Counties, ideal for the highly directional ultra-short wave transmissions planned. Conversion of the south east tower involved civil engineering operations to re-model the Victorian rooms to provide two studios (one each for the rival companies), certain shared

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<sup>638</sup> Cock, "Report on the Baird and Marconi-EMI".

<sup>639</sup> Ibid.



facilities such as the sound transmitter, the distinctive mast and aerials plus all the facilities that the BBC needed to actually support programme making. The decision to co-site the transmitter and aerials with the studios directly below the aerials was a mistake. The high-power ultra-short wave transmissions affected the studio equipment beneath: an often repeated story by former Alexandra Palace engineers describes a musician's problem with induced voltages on a music stand struck by a baton, resulting in showers of sparks.<sup>640</sup> Figure 6.2 shows the mast atop the offices with the studios just to the left behind the archways.

By the summer of 1936, both Marconi-EMI and BTL had their technical equipment in place and working, albeit with frequent break-downs. It was planned that the station would go on the air with both systems sometime in the late autumn, and the BBC producers were beginning to pull together their ideas for programmes. Domestic television receiver manufacturers were having difficulty keeping the price of sets down, due largely to the cost of the CRTs coupled with the complexity of the supporting circuitry, and the number produced was only about 400, even by the official opening date of November 2<sup>nd</sup> 1936.<sup>641</sup> At that time, prices for a basic set without sound radio ranged from 85 to 105 guineas, or about the price of a small car.<sup>642</sup> Technically, by the summer of 1936, both systems of pick-up and transmission worked, and were on target for a formal launch. The same could not be said about the sales of domestic receivers and public relations.

#### **6.4.2 The problem of the rival technical standards as manifested in the domestic television set**

A prospective television owner was not immune to any future systems battles on the technical front, because although the two rival television systems of 1936 had been made as compatible as possible, developments could still render sets useless. The potential purchaser of such an expensive item would either have to be rich enough to not bother about possible rapid obsolescence, or confident enough that the set they were buying would have a good chance of remaining useful and usable for a

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<sup>640</sup> Norman, *The Story of British Television*, 205-206.

<sup>641</sup> Elen, "Television Comes to London".

<sup>642</sup> Geddes and Bussey, *The Setmakers*, 245.

reasonable length of time, unlike the 30 line sets that had been made completely obsolete in 1935. All of the high-definition consumer television sets on offer to the British public were based on all-electronic CRT displays, except for one: the hybrid projection device manufactured by Scophony Ltd. employing a novel light valve technology, as I described in Section 3.5. Very few (if any) Scophony sets were ever sold, but this was probably due to the price of 220 guineas.<sup>643</sup> Compared to a wireless set, a television set was a very expensive item, and the price was always a huge worry to manufacturers and retailers, despite initial optimism.<sup>644</sup>

As the systems used were to alternate on a weekly basis, any television set had to be dual-standard and work satisfactorily on both systems, with easy changeover for non-technical users. Technically this was not too difficult to engineer, if the set had been designed at the outset as capable of operating with the more demanding 405 line system. Marconi-EMI worried about the ability of other consumer television set manufacturers to work with their television standard: in an internal memorandum to Shoenberg, Marconi-EMI engineer, C S Agate, reflected on the problems that other manufacturers would have with the 405 line system.<sup>645</sup> Both systems used a common sound and vision carrier frequency on the relatively untried ultra-short wave band, with receiver design placing huge demands on the available valves. The format of the BTL standard resulted in a transmitter vision bandwidth requirement of about half that of the Marconi-EMI system, a considerably easier proposition to design and produce, but the need for dual-standard working ruled out this advantage.<sup>646</sup>

The significant technical differences for manufacturers lay in the display side of the television set: the CRT scanning and synchronisation systems. Sets were being manufactured by nine manufacturers, two being divisions of EMI and BTL. Besides Marconiphone/HMV (brand names of EMI) and Baird, sets were made by A C

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<sup>643</sup> Singleton, *Story of Scophony*.

<sup>644</sup> Geddes and Bussey, *The Setmakers*, 245. Explains the optimistic marketing predictions and the price cuts that followed.

<sup>645</sup> *Ibid.*, 229.

<sup>646</sup> With the relatively low carrier frequencies employed, the video bandwidth was a significant fraction of this, leading to problems with transmitter tuning. A reduced video bandwidth eased these issues considerably.

Cossor Ltd., Pye Ltd., GEC Ltd., Ferranti Ltd., Scophony Ltd., Philips Ltd. and Halcyon Ltd.<sup>647</sup> All had to make their sets work well on both of the technical standards, but the Marconi-EMI system, having a horizontal frequency of 10.125 kc/s compared to BTL's 6 kc/s, presented the most difficult challenge. Furthermore, the Marconi-EMI interlaced scanning system placed extra requirements on the circuit design if advantage of this feature was to be taken up. With poor, or non-existent interlace performance, the Marconi-EMI standard fell to 202.5 lines, actually a worse vertical resolution than that of BTL.<sup>648</sup> The initial production models of consumer sets were mostly incapable of resolving much more than 200 lines due to the poor focusing capability of the CRTs so the issue was academic. Even without good spatial interlace performance, the Marconi-EMI system would always exhibit less flicker than that of BTL, albeit at the expense of a little more design complexity and a small price penalty.

The common sound system was amplitude modulated (AM), but since it was being transmitted at ultra-short wave with an audio bandwidth of 12 kc/s, and not subject to the fading and interference of the long, medium and short wavebands of conventional domestic wireless, the quality was very high, much better than hitherto experienced by the domestic consumer. This very high quality (but shared) feature of the two systems does not appear to have been highlighted in contemporary advertising, yet several designs appeared in technical wireless magazines for television sound-only receivers to take advantage of the transmissions.<sup>649</sup> BBC Engineer in Charge at the London Television Station, Douglas Birkinshaw, recalled that 'The vision, of course, was the novelty but the sound quality was superlative. Every bit as good as modern UHF'.<sup>650</sup>

The BTL system flicker was not as major an issue as it might first appear. Both systems' images were relatively dim, limited by the CRT performance, requiring

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<sup>647</sup> Geddes and Bussey, *The Setmakers*, 227-245.

<sup>648</sup> The 405 line picture being delivered in two interlocking fields per frame 'collapsed' to one of  $405/2 = 202.5$  without operational interlace.

<sup>649</sup> Dowding, "The 'Television' Three"; Scott-Taggart, "A Television Three".

<sup>650</sup> Norman, *The Story of British Television*, 120.

drawn curtains and/or subdued lighting. Human vision flicker perception quadruples for a doubling of brightness (a square law relationship), and increases proportionally with image size (a linear law). The quite dim, small-screened television sets of 1936, when viewed at the recommended distance of five times picture height, did not begin to approach the fields of view or brightness associated with severe flicker fatigue. Furthermore, the cinema industry, with its large and increasingly bright images, was still subject to flicker problems and was attempting to reduce the visibility of flicker using new techniques, but in many cinemas flicker was still prevalent and audiences were, to a large extent, tolerant of the problem. Thus, I believe that the public of the time was probably less sensitive to the flicker problem than the television engineers feared. My own replication work has confirmed this: the viewer becomes attuned to the flicker and ceases to be aware of it (see Appendix 6.2).

Most potential purchasers would not have understood the technical detail of television, but the ramifications of the differences did limit the marketing claims for television sets. To avoid confusing the public, any attributes unique to one system could not be mentioned, thus the benefits of the Marconi-EMI system with regard to flicker were not mentioned in advertising for television sets (see Figure 6.7). Manufacturers concentrated on descriptions of the picture size and sound quality, the design features of the cabinet, and any other features such as built in wireless sets and/or gramophones. In the popular technical publications of the 1930s, a much deeper analysis of the two systems took place examining the systems in great detail, but largely without passing judgement on their relative merits and demerits.<sup>651</sup> So far as the viewer was concerned, despite all of the technical differences, a domestic television only needed the operation of a single standards switch (this altered the horizontal line rate) and some minor adjustments to the hold (synchronising) controls, picture size adjustments, focus, brightness and contrast in order to change the system. Confidently, one anonymous technical writer wrote: ‘the merest tyro cannot fail to obtain excellent results after five minutes experience ...’.<sup>652</sup>

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<sup>651</sup> “The first complete details”, *Television and Short-wave World*.

<sup>652</sup> “Tuning for Best Results”, *Television and Short Wave World*.

## **6.5 Establishing the high-definition BBC television service**

With the cost of a high-definition television receiving set so high, journalists ruminated about whether the BBC Television Service would, as many expected, turn out to be elitist, the preserve of the rich, and all at the expense of the licence fee payer.<sup>653</sup> The BBC of the mid-1930s was already coming under regular attacks in the press, and suffering audience desertion as I described in Section 6.3.2. It was essential to circumvent suggesting to a potential purchaser that the service could be another short-lived experiment that might be discontinued (as happened with the earlier 30 line low-definition electro-mechanical service). Leaks to the press proved to be a problem, with speculation about the service even before the Television Committee had reported about the technical details of both systems.<sup>654</sup> The running of the new television service was to be under the auspices and day-to-day control of the BBC and to be their responsibility with the Corporation as the authority in charge. However, there was a need for the government, the GPO and the manufacturers to all help make the public presentation as favourable as possible, even if the initial take-up might be small. All had to work together, despite the station being a competition between the two leading television companies. To avoid adverse publicity, the presentation of the competition to the public required careful handling from all parties.

As I have described in Section 1.4, from the late 1920s to the early 1930s, the British public had been regaled in the press by the activities of Baird himself, and later by those of his company, BTL. Baird sought out publicity and press coverage for his low-definition electro-mechanical 30 line television system whenever he could, and commercially this made sense from several points of view: it increased sales of the home receivers, increased pressure on the BBC to continue to provide transmission facilities on the medium waveband, and reassured investors that backing his company financially was a sound move. In 1936, Baird was no longer in charge of the company which bore his name, but he still remained an important figure in terms

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<sup>653</sup> Barrington, "Another Ten years of the BBC", *Daily Express*, 1936.

<sup>654</sup> "Television for the Nation", *The Observer*, 1934.

of publicity and public perception because he had ‘invented television’ and the British public firmly associated him with the technology.

With the announcement of the high-definition service in February 1935, followed by the closure of the 30 line electro-mechanical service in September 1935, the attention of the lay press had to be steered towards high-definition television. The short period from the government decision to go ahead with the station and the planned opening before the end of 1936, meant that all parties had little time to explain, enthuse and encourage the British public. The public was wary, being already disappointed with the reality compared to the promises of Baird’s electro-mechanical service as delivered by the BBC. Furthermore, the reasons for the trial of the two systems, and what this would mean in practice to potential viewers with regard to the long-term prospects for high-definition television, all had to be explained. For Baird personally, this was what he was used to, with press briefings and demonstrations, but the previously secretive Marconi-EMI had to devise a strategy that countered BTL, without putting off the general public by implying future uncertainty about standards and equipment.

The British Government began the process of public information early, with Wood, the Postmaster General, broadcasting on the BBC wireless on January 31<sup>st</sup> 1935, saying:

This afternoon, in the House of Commons, I announced the most important decision of the government on the subject of television, that latest miracle of scientific achievement which is now arousing so much interest. Broadcast television can perhaps best be described if I ask you to imagine that in the centre of your present wireless set there was a little square of glass on which you could now see me, as I sit here in the studio at Broadcasting House. Whether the picture would add to your enjoyment it is not for me to suggest. However, it is proposed that two television systems of High-Definition Television should be tried at the London station.<sup>655</sup>

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<sup>655</sup> Norman, *The Story of British Television*, 108.

Wood began with the concept, and then explained the competition, but he had ignored what a viewer might see in the way of programmes. He was not in a position to really know what the new high-definition television service would offer from a programming perspective, the Television Committee Report had expressly noted that this was a matter for the BBC to decide, and in any case the BBC's plans for television were still being formed at that time.<sup>656</sup>

High-definition television was a difficult concept for the general public to understand, but given the added complexity of the two-system trial, and the poor response so far to television in the form of the low-definition electro-mechanical service, the BBC, the government and industry all faced a difficult task with regard to publicity. Newspaper science correspondents concentrated a number of articles on the CRT itself. This was one of the key common elements, at least so far as the domestic receiver was concerned, as noted by the *Guardian*, but not something that the lay public would be able to quickly grasp.<sup>657</sup> Even as late as 1936 the perception (at least in the technical press) was that the wider public still did not understand what television really was. The editorial of the March 1936 issue of *Television and Short Wave World* reflected that 'It is very evident that the general public, as represented by the "man-in-the-street", is mostly lamentably ignorant concerning television'. The editorial continues, 'In the daily press television is practically taboo, or else there is the other extreme of wild statements which have no foundation in fact'. It concludes:

Then there is the too optimistic person who is under the impression that some little addition to the ordinary wireless set will enable him to receive programmes, or again, that he will be able to have pictures which will occupy a considerable portion of one of the walls of an average sized room. There is in fact no end to the amazing ideas that are current and the sooner they are removed the better.<sup>658</sup>

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<sup>656</sup> Report of the Television Committee, 1935.

<sup>657</sup> "Cathode Ray in Television - The Essential Factor", *Guardian*, 1935.

<sup>658</sup> "Comment of the Month", *Television and Shortwave World*, 131.

Beyond the technical press, the cinema was suggesting its own ideas to the public about television. Two Hollywood films gave a very false impression of what television could do and how it did it - both films feature television systems which work point-to-point, seemingly over any distance, and without the need for aerials or wires.<sup>659</sup> Hollywood's concept of a television camera is shown in Figure 6.3, a still from *Caught by Television*.

The press latched onto the competition as a new story about television, with the publicity seeking BTL, in the tradition of Baird himself, on one side and the secretive Marconi-EMI on the other. The initial message of the BTL publicity was to state firmly and clearly the company's experience in television, and the significant investment made in the Crystal Palace facility. Sir Harry Greer, the BTL Chairman, in his reported speech at the company annual general meeting, gave a comprehensive review of company research, results and future plans, highlighting the Crystal Palace facility in defiant terms, saying:

Since last February, we have given no less than forty demonstrations of complete programmes, all of which have been successful, and these have been seen on Baird "Televisors" in various parts of London by over two thousand people in all walks of life, who have had nothing but praise for the results achieved.<sup>660</sup>

Marconi-EMI had nothing to counter this kind of statement of experience, and remained relatively silent.

As a counter to the rather dry technical aspects of the competition, interest was kindled by the press in the peripheral issues that might capture the imagination of the general public. The most significant of these enthusiasm building campaigns was discussion of what the user of a television set should be called, running in the *Daily Express*, and the widely covered quest to recruit the people who would actually be

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<sup>659</sup> Sanforth, *Murder by Television*; Lord, *Caught by Television*. In Britain, the film title was *Trapped by Television*.

<sup>660</sup> "Baird Television (Limited) - Success of transmissions from Crystal Palace", *The Scotsman*, 1935.



the on-screen presenters of the new service.<sup>661</sup> One of the failings of the new television systems was inadvertently highlighted in this reporting – the problem of the excessive response of the television system to red, which made anything red appear a very bright white. The BBC job advertisement for the ‘female announcers’ specified several requirements of the applicants, including a bar for redheads:

The BBC is conducting a search for Superwoman. She must have a super personality, charm, tact, a mezzo voice and a good memory. She must be as acceptable to women as to men. She must photograph well. She must not have red hair and must not be married.<sup>662</sup>

The response was huge: the *Daily Sketch* reported that ‘5000 want one Job’.<sup>663</sup> It helped the press coverage that one of the winners of the ‘competition’, Jasmine Bligh, was a niece of Lord Darnley and descended from Captain Bligh of the *Bounty*. The saga continued later with the male presenter, the *Daily Mail* reporting: ‘TV Adonis Found’.<sup>664</sup>

Given the tight timescale leading up to the opening of the London Station, the build-up also attracted some attention as a race against time – often a favourite theme for the press – with a serial form and unpredictable events. When there was nothing to report, some new scare story might surface. For example, just as advertisements from manufacturers for actual sets began to appear, so did stories about the new ‘wonder’ of television. ‘Could it see into people’s homes?’<sup>665</sup> ‘Will television sterilise the population?’<sup>666</sup> Another worry carried by the press was the effect television might have on existing institutions such as the music halls and theatre. The editorial of the theatrical newspaper, *The Stage*, complained: ‘Television holds out

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<sup>661</sup> Norman, *The Story of British Television*, 82.

<sup>662</sup> *Ibid.*, 86.

<sup>663</sup> “5000 want one Job”, *Daily Sketch*, 1936.

<sup>664</sup> “TV Adonis Found”, *Daily Mail*, 1936.

<sup>665</sup> Norman, *The Story of British Television*, 82.

<sup>666</sup> *Ibid.*

all the prospects of another huge expansion of cut price mechanical entertainment for the millions'.<sup>667</sup>

The coverage in the press was undoubtedly fairly lightweight: journalists had little more to base their stories on other than speculation and the matter-of-fact technical construction and development at the Alexandra Palace. However, as the television mast approached its full height, it became a focal point for press and public interest, towering over the old 'peoples' palace'. Alexandra Palace had been a landmark for six decades, but the 225 foot lattice mast standing on top of the six-storey south-east tower of the building could be seen from many miles distant (see Figure 6.2). This structure captured the imaginations of the people of north London, dominating the actual Alexandra Palace Park area and becoming a symbol of 1930s second generation modernism. The mast, which is still in use today, is an image which retains potency in Britain, as an icon of 'old television' and 'BBC values' (see Figure 6.5).

It might be assumed that the geographic range of the 'London Station' would limit interest to London and the Home Counties, given the virtual certainty of no long-range reception being possible on the ultra-short waveband, but this was not the case. Newspaper coverage was national, with interest shown from all over the country, especially in Scotland, which wanted its own station as soon as possible.<sup>668</sup> It had been made clear in the Television Committee Report that a national network was planned, but there were no dates or details suggested.<sup>669</sup> With nothing firm in terms of programme plans, a service only available in Greater London, and television sets that were already known to be very expensive, the arrival of high-definition television might have appeared to not be particularly interesting in the short-term. Despite all of these factors, the wireless industry was still concerned about the potential effect on sales. Their response was to try to ensure that sales of ordinary wireless sets were not affected by countering optimistic reports about the spread of high-definition television. This had been a worry for the industry for some time, and

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<sup>667</sup> "Machine Pay", *The Stage*, 1935.

<sup>668</sup> "Television - Why is it Retarded?", *The Scotsman*, 1937.

<sup>669</sup> Report of the Television Committee, 1935, 18.

newspaper articles appeared quoting the views on this of industry figures, as well as government officials.<sup>670</sup>

By March 1936 the technical equipment was being moved into Alexandra Palace and appropriate press releases followed. Marconi-EMI stressed the ‘flicker-less nature’ of their picture describing their camera (the emitron) as the ‘electric eye’. BTL described their equipment as ‘perfect in every detail’ and claimed ‘the whole installation, with typical British thoroughness, is built as solidly as the electrical installation of a battleship’.<sup>671</sup> It was still unknown what a potential viewer might actually be able to see in terms of programming on the new service, and whether it would be successful as a new popular medium. Newspaper reports were very vague about the programmes to be offered. *The Scotsman* reported:

Mr Gerald Cock, Director of Television, is busy trying to devise the type of programme which will be most suitable. This is no easy task because of the severe limitations of the medium. It is said that definition of the pictures, while not so clear as that of a good newspaper illustration, will be as distinct as that of a home cinema projector.<sup>672</sup>

By the summer of 1936, the press was no longer interested in the project and momentum was being lost. BBC historian, Asa Briggs, has commented: ‘the long and inevitable delay in providing a television service could best be brought to an end by a burst of activity that would capture the public imagination’.<sup>673</sup> Interest was regained in early August 1936 when Cock told his staff that they would be going ‘live’, broadcasting to the RadiOlympia wireless industry exhibition, at the Earl’s Court Exhibition Centre in London on August 26<sup>th</sup> 1936.<sup>674</sup> This was a surprise to everyone, and the race to produce ‘real’ television with the equipment still only at the later commissioning stage, was another story that the press could work with. This was an opportunity to test out the station’s technical systems, plus the BBC’s

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<sup>670</sup> “Television - Still in the Experimental Stage”, *The Scotsman*, 1935.

<sup>671</sup> Norman, *The Story of British Television*, 121.

<sup>672</sup> “Television”, *The Scotsman*, 1936.

<sup>673</sup> Briggs, *The Golden Age of Wireless*, 552.

<sup>674</sup> Swift, *Adventure in Vision*, 75.

programme-making abilities, and at the same time gauge the public's reaction to both. In addition, it was thought by the wireless industry, and by the BBC, that the publicity gained by this unexpected trial opening might help sales of the very expensive consumer television sets. Journalists and reporters found plenty more stories, again mostly trivial. Appendicitis struck down Bligh while the other female presenter, Elizabeth Cowell, succumbed to a serious chill. BTL's equipment was reported as being sabotaged, with the *Morning Post* blaming 'parties' who considered their livelihoods to be under threat from television.<sup>675</sup>

Manufacturers had sets for sale, and the 1936 RadiOlympia was the place to launch and demonstrate them. Figure 6.7 shows representative samples from the two of the foremost manufacturers, BTL and Marconiphone, both showing the fine workmanship of their cabinets.<sup>676</sup> Even the most basic models in 1936 were well beyond the reach of most people, and the grand designs and options of built-in wireless sets and/or a gramophone added to the up-market impression that such advertisements must have created. The press gave extensive coverage of television at RadiOlympia, with praise and criticism in equal measure, of both the technology and of the sample programmes presented. The programmes paraded before the 123,000 people who passed through the public demonstration booths at RadiOlympia were a mixture of small-scale music hall with 'turns', orchestral items and topical features.<sup>677</sup> The technical quality of the pictures (relative to the electro-mechanical pictures) was good, but not as high as expected. The programmes on offer were not as good as had been anticipated either, with criticism aired in the press.<sup>678</sup> What the BBC considered to be important about the show was that both the television systems worked, and worked relatively reliably, despite several breakdowns of ten minutes and more. The BBC's Ashbridge wrote an account of the event for Varley Roberts,

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<sup>675</sup> "Sabotage Attempt at RadiOlympia", *Morning Post*, 1936.

<sup>676</sup> Marconiphone was by 1936 a subsidiary of EMI Ltd., not MWTC Co. Ltd., as the company had sold its domestic receiver manufacturing division in 1929 to the Gramophone Company Ltd., the antecedent of EMI Ltd. The right to use the signature and associated brand name, 'G. Marconi', was also sold to the Gramophone Company at the same time. See Section 5.2.

<sup>677</sup> Swift, *Adventure in Vision*, 76.

<sup>678</sup> Marsland-Gander, "Radiolympia", *Daily Telegraph*, 1936.

the TAC Secretary. He stated that both systems were ‘quite good’ but he had ‘seen better EMI transmissions’. He concluded that on the whole the press reaction had been ‘favourable and helpful and is inclined to gloss over defects ... but I should not say that at the moment that opinion is entirely unanimous that the transmissions are fit for regular programmes’.<sup>679</sup>

The culmination of the public relations exercise was a high-quality newsreel style film presentation produced by the BBC celebrating the whole Alexandra Palace television project.<sup>680</sup> The film was originally shown in cinemas, but it was later shown on the fledgling television service itself. It is the only visual record of the build up to the opening and is memorable as it features all aspects of the project, from the technology of the cameras to the plastering of the studio walls, and from the Frankenstein’s laboratory like images of the transmitters to laying the drains. The highlights are undoubtedly the aerial shots of the actual construction of the mast and a version of part of the opening programme of the service; a specially composed song, ‘*The Magic Rays of Light*’, sung by Adele Dixon, a popular singer and actress. The lyrics describe the wonder and optimism of the new service:

A mighty maze of mystic, magic rays  
Is all about us in the blue,  
And in sight and sound they trace  
Living pictures out of space  
To bring a new wonder to you.

The busy world before you is unfurled -  
Its songs, its tears and laughter, too.  
One by one they play their parts  
In this latest of the Arts  
To bring new enchantment to you.

As by your fireside you sit,  
The news will flit,  
As on the silver screen.  
And just for entertaining you  
With something new  
The stars will then be seen. So...

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<sup>679</sup> Norman, *The Story of British Television*, 14-23; Burns, *Television*, 523-526.

<sup>680</sup> Bower, *Television Comes to London*, BBC Film, 1936.

There's joy in store  
The world is at your door -  
It's here for everyone to view  
Conjured up in sound and sight  
By the magic rays of light  
That bring Television to you.<sup>681</sup>

The actual opening of the service was low-key, and the press gave it little coverage, despite all of the publicity and interest during the build-up. Reith was not present but Baird was there, although only in the audience. Overall, the opening was an anti-climax. For BTL, the competition was over almost before it had begun, at least for the 'wireless with pictures' model, which was not the forte of its systems. A devastating fire at the BTL Crystal Palace facility on November 30<sup>th</sup> 1936 took its toll on the company, and it was necessary to re-group and re-focus on other television related business.<sup>682</sup> The company rebuilt the Crystal Palace facility at nearby Lower Sydenham, and continued with their cinema television interests, working to perfect live television to cinemas, manufacturing consumer television sets, and developing television aerial reconnaissance systems for the military based upon the much-criticised intermediate film scanner technology.<sup>683</sup>

The competition lasted for another two months before the service continued solely on the Marconi-EMI system, which, for live television production, was a clear winner, just as had been predicted by BBC and GPO engineers. The model for television broadcasting had been confirmed: it was 'wireless with pictures', run by the BBC and using all-electronic technology. RCA and Marconi-EMI had secured the technological and commercial lead and BTL had largely been neutered as a threat, both technically and as a potential rival to the BBC. The BBC, the GPO and the British Government had achieved its goal of maintaining and extending the Corporation's monopoly. With a new Charter in place, challenges would be unlikely.

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<sup>681</sup> Source: BFI Screen Online. <http://www.screenonline.org.uk/tv/technology/technology5.html>  
Lyrics by James Dyrenforth and music by Kenneth Leslie-Smith. Accessed 05/02/2008.

<sup>682</sup> Kamm and Baird, *John Logie Baird*, 286-289. The fire did not begin in the BTL occupied part of the building, see: Brown, "Electronic Imaging", 178.

<sup>683</sup> Hills, "British Military Television", 161-168.

Over the next three years, before the service was closed down for the duration of World War II, the range and quality of the programming improved, and the reliability of the technical equipment advanced greatly. By the time of the close-down in September 1939, it was estimated that there had been 18,999 domestic television sets sold, and the predictions for 1940 were for a total of 100,000 sets.<sup>684</sup> In September 1939 the high-definition television service in Britain was growing rapidly, but the need to conserve technical resources and ensure security meant that it would have to close down during the hostilities.

The dream of television was on hold; at least so far as Britain was concerned. It did not re-appear until 1946, but the Marconi-EMI 405 line television standard, with only very slight amendments to the technical specifications, remained on-air in Britain until 1985.

## **6.6 Conclusions**

I have shown that the commercial timing for introducing a new high-definition television service was wrong: the Great Depression was still at its height, and the wireless industry was not in a position to handle the launch of what was likely to be a successful and disruptive new medium and market. Without an over-riding political incentive, such as occurred in Germany in 1935, and in the USSR in late 1937, the establishment in the mid-1930s of a full high-definition television service was unlikely to happen. Experimental stations, with no major commercial commitments to technical standards, programming and long-term viability, were commercially feasible, but not a fully financed continuing service. The companies working on the technical development of all-electronic television had succeeded in developing impressive prototype systems, but the equipment was still not proven in a full broadcast service environment, and consumer television sets were proving to be very expensive to make. It is virtually certain that there were no immediate military incentives to encourage the pace of television development and deployment – at least in Britain. Only the USSR and Germany had a real incentive to deploy high-definition television as quickly as possible, but neither country had to contend with

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<sup>684</sup> Geddes and Bussey, *The Setmakers*, 255.

commercial interests and launch timing for commercial reasons. The process set in motion in April 1934 in Britain by the British Government, the GPO and BBC, resulted in a market-bucking deployment of all-electronic television which had profound effects upon British broadcasting and the global development of the new medium. The GPO and BBC, working together, backed by the British Government, entered into a systematic plan to launch high-definition television service as soon as was practical. This service would ensure that the BBC established rights to maintain its broadcasting monopoly, whilst at the same time, extending it into the 'inevitable' territory of television. The arrangement suited the GPO, as with sound broadcasting fourteen years earlier, it had a strong desire to have only one broadcaster, thus heading off potentially embarrassing partisan decisions. The government was also convinced of the inevitability of the scale of television broadcasting in the future, and the pragmatic convenience of having the BBC take on television as a logical extension of sound broadcasting was attractive – if it could be achieved without political consequences. Difficulties might have arisen if a private company such as BTL had publicly lobbied for a broadcast television licence, as it had done in the early 1930s with regard to an electro-mechanical television service.

The competition between BTL and Marconi-EMI to provide the technical facilities for the transmissions was a much more evenly matched competition at the time of the Television Committee report than it became over the following two years. The BBC's early championing of Marconi-EMI as the system provider would never have been politically acceptable – especially as BTL's Baird had proven to be as adept as it normally was with publicity. The problem was compounded by the fact that EMI was partly owned by RCA, and that Sarnoff sat on the EMI board, giving BTL an opportunity to suggest that the company was essentially American (as I described in Section 5.2.3). Even the closed competition between the two companies could have proved to be politically embarrassing, but the Opposition leader, Attlee, either deliberately or passively, failed to capitalise on this anomaly.

From the time of the Television Committee's report, recommending that the BBC should take charge of television broadcasting in Britain, the Corporation had effectively extended its monopoly into the new broadcast medium, whichever company 'won' the competition. What was also still to be decided was the nature of



the television service on offer: 'wireless with pictures', or 'films to the home'. The competition was more than just a competition between two technical systems; it was a battle of two models of broadcasting. By the time of the opening of the service, the terms upon which it was to be contested had already been decided in favour of Marconi-EMI's system which excelled at live studio and outside broadcast television. This followed the existing model of live BBC radio programming, effectively ruling out any major influence by the film companies.

If the competition was a proxy for the battle between wireless and cinema control of television, it was also one between American, British and German technology. The Alexandra Palace London Television Station brought together all of the leading image pick-up and transmission technology for evaluation, effectively side by side in adjacent studios. RCA's iconoscope technology, in the form of the emitron, was pitched against Farnsworth's image dissector, Baird's flying spot method and the Telefunken intermediate film system. I have shown from contemporary reports and from my own practical replication trials, that the images produced by the two systems were much closer in quality than the 'headline' figures of 240 and 405 lines suggest. I have also shown that Shoenberg was relatively safe in his choice of 405 lines, 25 frames interlaced, as this was effectively an Anglicisation of the American 343 line, 30 frames interlaced system which demonstrably worked.

With regard to the end users – the television viewers – they had no choice in the selection of the final system. The BTL system was shut down by February 1937 with the London Television station continuing solely with the Marconi-EMI system. The users at the studio in the form of the technical staff and performers, certainly exhibited a preference for the Marconi-EMI system with its strengths in 'live' production, but the service was being forced down this path, based on the assumption that television was 'live' and not prepared on film, a medium which was well understood. The take-up of the television service by the public in the London area was then something which would depend upon the perceived merits and the appeal of the technology. RCA's analysis of what constituted a 'good enough' picture appears to have been thorough and the public accepted the image quality, if not the actual programming. The end user in this process was secondary to the political goal of establishing a BBC controlled television service.

## Chapter 6 Figures



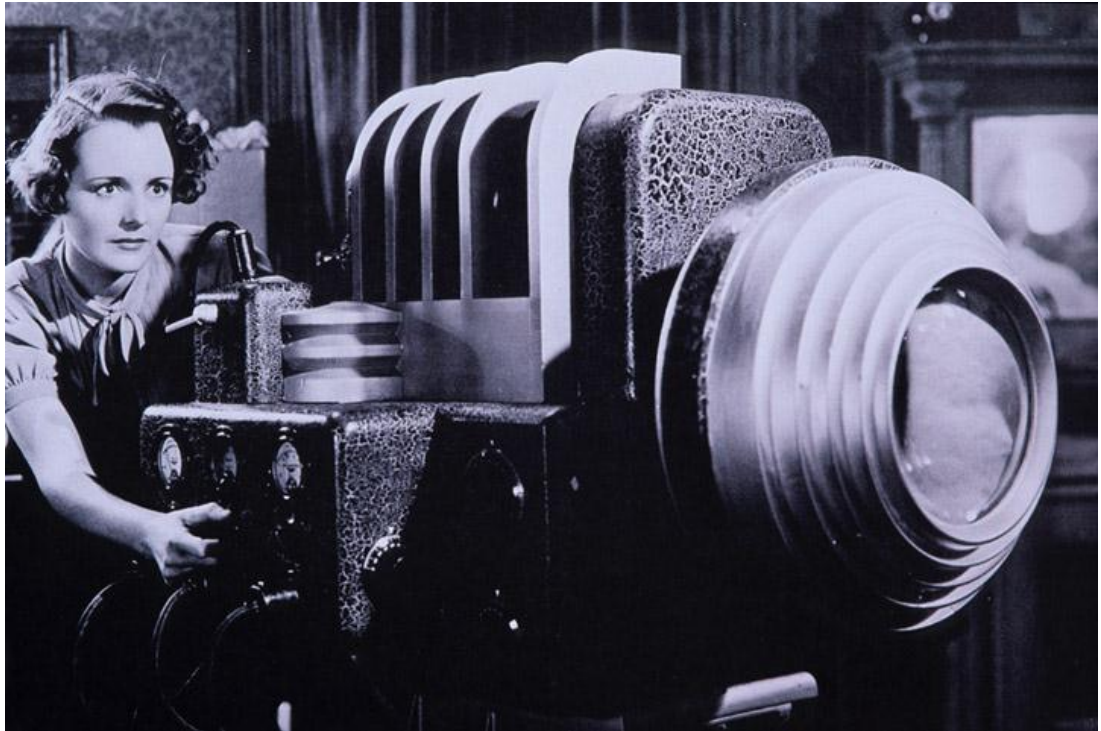
**Figure 6.1 Nazi television announcer with modern sub-title overlay.**

Picture source: picture still from –  
Kloft, M., *Das Fernsehen unter dem Hakenkreuz Television Under the Swastika*,

**Figure 6.2 The London Television Station - Alexandra Palace transmitter tower.**

Picture source: BBC  
Written Archives





**Figure 6.3 Caught by Television – Hollywood’s idea of a television camera**  
 Picture source: Lord, D., *Caught by Television*, still from the film.

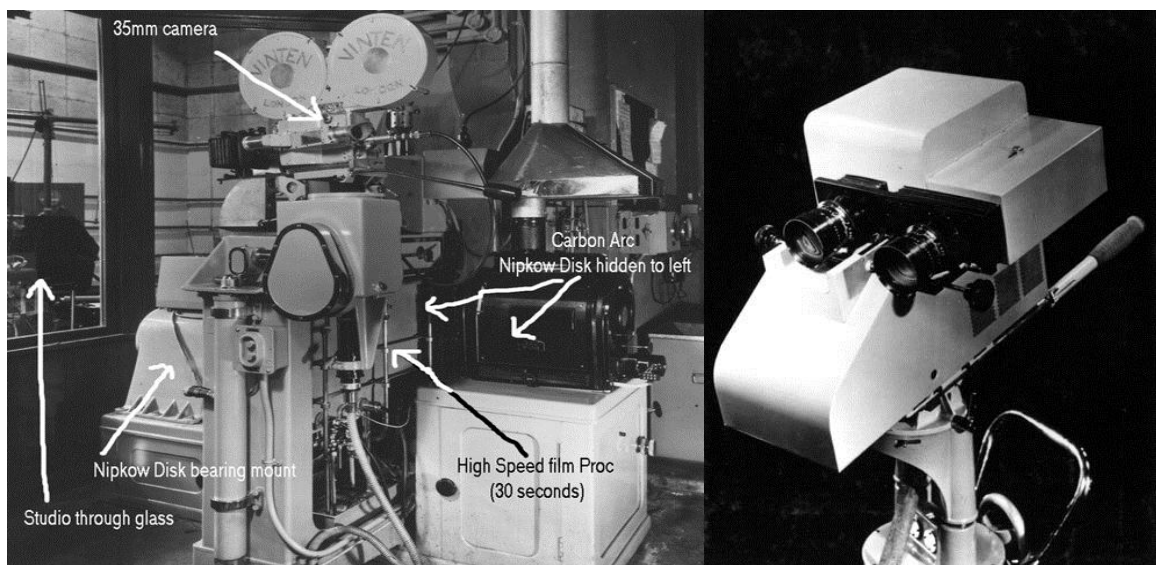


**Figure 6.4 RadiOlympia test transmission – the Alexandra Palace Marconi-EMI studio in August 1936**

Picture source: Elen, R  
 Fools on the Hill: part 2  
<http://www.ambisonic.net/tv2london2.html>  
 Accessed: 19/03/2011



**Figure 6.5 Iconic Alexandra Palace TV transmitter mast, as featured in the opening sequence for the BBC television news.**  
Picture source: BBC Written Archives.



**Figure 6.6 BTL Intermediate Film Scanner Camera (left) and Marconi-EMI Emitron camera (right) for comparison.**

Picture sources:

[http://tig.colorist.org/wiki3/index.php/Image:Baird\\_FSS\\_intermediate\\_system.jpg#file](http://tig.colorist.org/wiki3/index.php/Image:Baird_FSS_intermediate_system.jpg#file)  
and <http://www.doramusic.com/Emitron.jpg> respectively. Accessed 07/02/2008





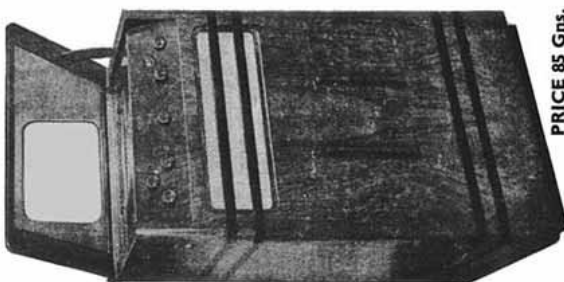
★ Marconiphone Television Model 701 includes not only equipment for Television with the appropriate sound programme, but also a superb e-valve all-wave superhet receiver capable of world-wide reception. It also has a magnificent sound and picture appearance this magnificent instrument is in every way typical of the exclusive Marconi standard.

★ The "sound" and "vision" equipment of Marconiphone Television Model 702 is similar to that incorporated in Model 701, but the instrument does not include the additional all-wave superhet receiver. It is available for listeners who already possess a suitable receiver for ordinary broadcast reception.



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**Figure 6.7 Contrasting 1936 dual standard models by Marconiphone and Baird. The more utilitarian Baird model is still expensive at 85 Gns. Compared to the more elegant and upmarket Marconiphone model at 105 Gns.**

Picture source: [www.tvhistory.com](http://www.tvhistory.com)  
Accessed 29/10/07

## Appendix 6.1 The rival television standards

Table 6.1: The London Television Station: Comparison of the Baird Television Ltd 240 line and Marconi-EMI Ltd 405 line systems as of November 1936		
	Baird Television Ltd.	Marconi-EMI Ltd.
Basic Television Specification		
Lines	240	405
Fields/second	25	50
Interlace	No	Yes, 2:1
Vision/Sync Ratio	6:4	7:3
Aspect ratio	4:3	5:4
Horizontal frequency	6 kc/s	10.125 kc/s
Transmitter Equipment (Vision)		
Modulation type	AM	AM
Modulation polarity	Positive	Positive
Modulation coupling	AC	DC
RF power output, CW	17kW	17kW
Carrier frequency	45 Mc/s	45 Mc/s
Output valve type	Metrovick demountable Tetrode	Sealed off, neutralised Triode
Video Bandwidth	1.5 Mc/s	2.5 Mc/s
Sound/Vision carrier separation	3.5 Mc/s	3.5 Mc/s
Total channel bandwidth	5 Mc/s	6 Mc/s
Shared Marconi Transmitter Equipment (Sound)		
RF output power, CW	3 kW	
Carrier frequency	41.5 Mc/s	
Modulation type	AM	
Audio bandwidth	12 kc/s	
Shared Antennas		
Sound and Vision polarisation	Vertical	
Height ASL	615 feet	
Antenna type (sound and vision)	2 off ‘turnstile’ antennas, each comprised of 8 dipoles	
Studio Pick-up Equipment		
Live cameras	1 off intermediate film scanner 1 off spotlight scanner 1 off image dissector	3 off emitron (iconoscope)
Telecine	2 off mechanically scanned custom built units	1 off emitron with Mechau film projector

## **Appendix 6.2**

### **Replicant technology experiments**

As part of my analysis of the two British systems on trial, I turned to replicant technology to test some of the contemporary claims made by the BBC and journalists about the superiority of the Marconi-EMI system. As I have noted in Section 6.1, there are very few off-screen pictures of television pre-World War II, and establishing what the pictures actually looked like to a 1930s television viewer has not been easy. In this appendix, I will consider two aspects; firstly, the flicker – the severity of the well-known BTL defect, and secondly, the question as to how much sharper the 405 line Marconi-EMI pictures really would have been.

Firstly, it is to be noted that the decision of Marconi-EMI to go for the very high figure of 405 lines was not as adventurous or daring as is usually described in existing literature. The fundamental speed of the system is, as I have shown, not fundamentally any different to the 343 line, 30 frame interlaced system already proven by RCA using essentially the same technology. The difference in the mains frequency, which effectively determined the picture repetition (frame) rate, essentially equalises the fundamental speed requirements. Marconi-EMI would have had every confidence that 405 lines was an achievable goal, as that working speed had already been proven by RCA.

The main technical issue revolves around flicker perception, and how bad this would have appeared to a 1930s television viewer. My hypothesis is that it would have been a lot more tolerable than is usually presented in existing literature. Furthermore, compared to the 12.5 frames per second of the 30 line British electro-mechanical television, the improvement would have appeared to be tremendous. Coupled to the eight-fold increase in the number of television lines, the BTL system would also represent a huge general improvement in television definition.

My test rig was made up from two early 1970s Link 109 monochrome vidicon cameras (one on 625/25 interlaced, and one modified to 240/25, progressive)<sup>685</sup>, plus

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<sup>685</sup> ‘Progressive’ in this work infers ‘non-interlaced’.

two early 1960s Pye monochrome monitors (one on 405/25 interlaced with the other modified to 240/25 progressive). The 625/25 interlaced picture was down-converted using a digital 'Aurora' standards converter to 405/25 interlaced, and the pulses for the 240/25 progressive came from a Quantum Test Pattern Generator programmed to run at that rate. Sample pictures are shown in Figure 6.8.

The flicker on the 240/25 progressive system, if the brightness is kept down to pre-war CRT levels, is tolerable. Given a longer persistence I'm sure that it would have been almost unnoticeable, but there is no evidence that this technique was in use. Once it is accepted that the 405/25 interlace efficacy in the 1930s was poor, that CRT was not good, and that the transmission video bandwidth was inadequate to fully support the theoretical capabilities of 405/25 interlaced, then the 240/25 progressive pictures are comparable. They look more 'punchy' than the 405, and have a dynamic quality which is hard to explain. After watching 240/25 progressive for 5 or 10 minutes, the flicker is almost forgotten by the viewer. There are some issues with the test facility – aspect ratio being one, it was 4:3 for 240/25 progressive and originally 5:4 for 405/25 interlaced, but I consider these to be small errors.

BTL's telecine pictures have always been credited with being better than Marconi-EMIs, and that was down to the fact that the emitron was a poor choice for film scanning. It also underlines the fact that there probably wasn't a tremendous difference in the two standards as received in the 1930s home. My conclusion is that compared to 30 line work, a viewer would have said that 240/25 progressive was a huge leap, definitely having programme value, and that if a television service had been based on pre-shot film, rather than 'live' cameras, then the superior BTL telecine and 240/25 progressive would have proved to be adequate.



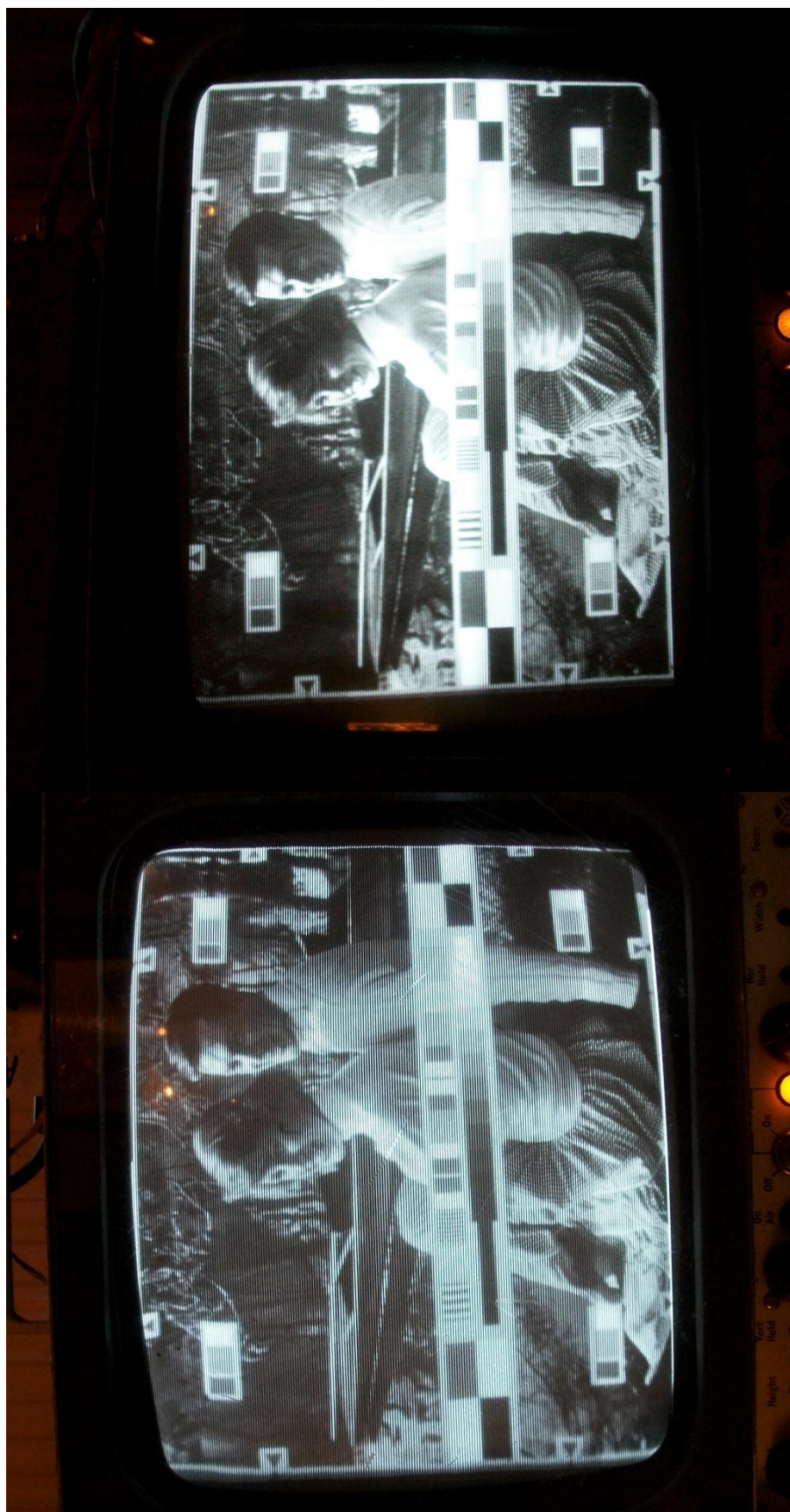


Figure 6.8 240/25 picture on the left, 405/50 picture on the right.

## Chapter 7

### Conclusions

In following how television emerged as a new medium, I have endeavoured to view the developments through the eyes of an interested contemporary observer, trying to understand what was happening and where the future was likely to lie. In its beginnings, 'distant vision' was the collision of a cluster of inventions and discoveries which resulted in a new quest to see remotely. The concept was being pursued by a small band of experimenters, thinkers and writers as an intellectual fancy, rather than as a strictly commercial or academic challenge. Over a period of 50 years the fancy waxed and waned, but it was never more than a tiny peripheral outpost on the technological landscape, with only small numbers of disparate investigators sporadically returning to the problem. It remained just a dream until the wireless boom of the mid-1920s caused a new surge in interest resulting in the old ideas being revisited. It became a reality as the old ideas evolved, and yielded functioning machines, all using the same German student's concept of 1884.

As with most other inventions, questions of simultaneity arise regularly throughout the almost 70-year period of the initial development of television which this thesis has addressed. The two major examples of this that I have examined in detail are those of the concepts of CRT-based television and the creation of the iconoscope/emitron television cameras. The first case supports the notion, whilst the second does not. The CRT-based television instance is one of original concept, whereas the iconoscope/emitron is one of a more detailed development of that idea. In that respect they are not directly comparable, but the cases do illuminate the debate on simultaneity by suggesting that the detail is key. Every proposed case of simultaneity is obviously different and no universal rules can apply. The detail must be examined in each instance.

My first example, that of Campbell Swinton and Rosing, considered whether their ideas on CRT-based 'distant vision' were one and the same (or perhaps from a third party), or simply simultaneity, born as a result of technological and social circumstance. This was, as far as can be established, a case of simultaneity. The two had no known common associates and were not well-known beyond their

specialisms, and their ideas were not completely identical. Rosing's British patent and Campbell Swinton's letter to *Nature* were almost concurrent, and the circumstantial evidence of geographic location, language and association, reinforces the presumption of simultaneous invention.

In the case of the iconoscope and the emitron, the evidence here is against simultaneity, despite strong and continuing claims to the contrary amongst most British writers and historians. The historical relationship tying RCA, MWTCO. and EMI together via patent rights and company ownership, is, on its own, quite strong evidence for collaboration. The shared personal culture, language and professional experiences of Shoenburg, Zworykin and Sarnoff is suggestive of an agreeable working relationship, some of this evidence surviving in correspondence. There are also the striking similarities in the two designs, the priority of the iconoscope, evidence of visits to the RCA laboratories by EMI engineers, and finally the BBC's presentation of Zworykin as 'the inventor of the television camera'. There are differences in the detail of the design, but the tube is essentially the same, with the important mosaic preparation method being patented by RCA and adopted by EMI. Furthermore, the system-level research work of Engstrom and his laboratory can be found embedded in the Marconi-EMI system. 405 lines at 50 fields with interlaced scanning is an Anglicised version of RCA's earlier 343 lines at 60 fields with interlace. Furthermore, there were other possible ways that such a system could have been created, either using Farnsworth technology or a different incarnation of the Rosing/Campbell Swinton concepts, as illustrated by the work of the 'Enthusiasts from Tashkent'.

The emitron/iconoscope and also the emiscope/kinescope were examples of industrial collaboration, straddling the Atlantic and bringing together two national networks of people. Both were successful development programmes, but what of the 'failures' such as Farnsworth's image dissector and the Nipkow disc? Definitions of failure figure highly in the development of television and are largely related to episodes in the deployments of electro-mechanical systems. The whole period lasted approximately ten years, from the rise of practical technology beginning in 1925, to the abandonment which began in early 1935. Gauging the success or failure of electro-mechanical television technology is problematical and depends heavily upon

perspective and context. From an economic perspective, it was a failure: no profits were made, and most of the new television companies collapsed. Purely as a technology, it was not a failure. It worked, although it never had more than curiosity value during the late 1920s and early 1930s. Attempts to improve the technology largely fell by the wayside as the newer, higher-definition, but much more costly, all-electronic techniques could be seen by early 1934. There was never much opportunity for social shaping of electro-mechanical television to occur, as it never emerged from the 'experimental' phase. Are these facts enough to warrant the term 'failure' or were there redeeming features?

One of BTL's engineers, Jim Percy, was probably the first to suggest that Baird's early efforts and inventions were not failures, because they stimulated what followed. Percy said:

He accelerated the television age. If it hadn't been for Baird shouting and yelling and putting his crude 30 line pictures all over London, we wouldn't have had television in this country before the war. He demonstrated that television could be done if not the way it should be done.<sup>686</sup>

Extrapolating this beyond the British case, the era of electro-mechanical services was successful because it raised public awareness of the existence of television and that this was what stimulated the large corporations such as RCA to begin investing in a much higher-definition all-electronic version. Taking the long view, this is probably a sound opinion, but what of the view from the perspective of a 1930s television user? The question is difficult to address, because most purchasers or builders of kits were not representative of the huge wireless audiences who were the real potential for volume sales and fully-fledged television services. Electro-mechanical television never reached even a beginning in mainstream audience acceptance and was already in decline almost as soon as 'services' began. Broadcasters did learn some technique from their own experiences of the technology, but little was of any use for later high-definition work.

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<sup>686</sup> Norman, *The Story of British Television*, 101.

If electro-mechanical television was a ‘useful failure’, what of the all-electronic, but nonetheless ‘failed’ BTL system at the London Television Station? The British trial of two high-definition systems was more than a trial of competing technologies: it was also a key step in determining the shape of television. The competition was real enough at its outset, with the Television Committee genuinely unable to decide between the two leading firms. The competing concepts, as I have termed them, were: ‘wireless with pictures’ and ‘films to the home’. Both could have worked commercially, but the needs of the BBC in terms of maintaining and extending its monopoly following the Charter renewal drove the whole process of the development of television broadcasting forward at a relentless pace. Either of the two competitors could have won, but the terms of engagement favoured ‘wireless with pictures’.

Within months of the announcement of the competition, the BBC’s favourite, Marconi-EMI, was already showing its superiority in terms of live (‘direct’) television. This was a convenient outcome for the BBC, both technically and commercially. Marconi-EMI would win the competition, but more importantly, the BBC would have asserted its monopoly and extended it into the new field of television. By January 1937, the new BBC Charter was in place and by default the Corporation was in charge of British television, having removed any threat for independent ‘films to the home’ style of service from BTL. The ‘direct’ television model, ‘wireless with pictures’, suited the BBC traditions of wireless broadcasting where everything was live and under the direct editorial control of the Corporation’s staff. This also suited the GPO, meeting its desire to only have one broadcaster to deal with, and it suited the British Government as the BBC was not a commercial operation. All parties, other than BTL, had what they wanted, but what of the poor, overlooked viewer? After poor initial programming, television in Britain was soon past the curiosity stage and on-target for 100,000 installations for 1940: the viewer was finally beginning to have a say.

What of the ‘losing’ model and system, the BTL 240 line format, with its strengths in ‘films to the home’? In Germany, admittedly with a propaganda-obsessed Nazi government directing the whole system, the ‘films to the home/viewing room’ model

was moderately successful. Technically, it was similar to that of BTL, and was producing pictures which did have entertainment (and propaganda) value, even without the flicker-reducing interlace system. The BTL system could have worked, and my replicative experiments confirm that the image quality was not the crucial deciding factor in the decision to favour Marconi-EMI. It is true that the Marconi-EMI emitron camera was very much easier to work with when producing largely 'direct' television. The cameras were quite compact and adaptable to the programme makers' needs, but these factors were only important for a 'wireless with pictures' television system.

The contingentist view that television did not have to develop as it did is reinforced by the Scophony advanced electro-mechanical television work. Scophony was well on course with its deployment of television to cinemas, as was BTL. By the outbreak of World War II in Europe, Scophony, in conjunction with the Odeon cinema chain and its electro-mechanical technology, albeit with new techniques and approaches far removed from the Nipkow disc, was enjoying success. Similarly, BTL, although not as successful (ironically using much less effective, dimmer and smaller screened CRT-based projection technology) was creating similar systems for its owner, Gaumont British Picture Corporation.

The systems trial of 1936 was an opportunity for interested broadcasting authorities outside Britain to see first-hand how the systems compared under similar operating conditions, albeit with the competition slewed in favour of live pick-up cameras. Sarnoff of RCA would have found the trial a very useful test of the iconoscope technology in action, and also a test of public and press reaction to high-definition television in a developed Western country. Finally, it was a test of pick-up, transmission and consumer CRT television equipment under real conditions, with the added bonus of a trial of marketing strategy and of consumer/press reaction. In the United States, RCA and other interested organisations such as Philco, the FRC and the movie corporations, would have been able to observe this proxy experiment in free-market television unfold, the conclusion of which was never reached due to the outbreak of the European war in September 1939 which resulted in the immediate close-down of BBC television and the abandonment of all cinema television deployments. In Britain, the battle-ground between cinema and television for viewers

and patrons would not resume until after World War II, resulting in the world-wide adoption in the 1950s of the ‘wireless with pictures’ model, or ‘direct’ television. Improved telecine machines and video tape recording then began to erode that model through the 1950s and 1960s, until today we have almost come full circle to the model pioneered by the German television service and BTL – ‘films to the home’, where almost every production is pre-recorded in one form or another. Only news, sport and state events are now ‘live’. The model which now dominates is very close to the one with which BTL could conceivably have won 1936, despite its ‘inferior’ television system.

My findings relating to the failure of electro-mechanical television, not being inevitable, and the BBC’s manoeuvring to ensure its monopoly of television, confirm the need to re-evaluate some of the established analysis. Furthermore, my conclusions with regard to the Marconi-EMI emitron and the RCA iconoscope have established collaboration, not simultaneity. This is not in accord with most of the existing secondary British literature. I have been hindered in my research by not having access to the EMI Ltd. Archive, which may become available in the future and offer opportunities for further investigation. I believe that there is scope for more tightly focused work, especially with regard to the processes surrounding the BBC’s acquisition of a monopoly of television broadcasting in Britain. This would shed light on how monopolies more generally fight and manoeuvre to maintain and extend their ‘rights’ to that status. I would suggest a re-evaluation of the BBC primary sources with the aim of looking for evidence for the manoeuvring. This might yield further insights into the relationships between MWTC., EMI, RCA, BBC, GPO and the British Government.

Other possible areas for further research are Western Television, Scophony and Russian/Soviet television history. A closer study of these will yield a better understanding of ‘failure’, and whether the ‘failed’ developments were vital for eventual success. Western Television and Scophony both present problems in terms of available information, but I believe that there must be more material to be found, especially in the case of Western Television, as there were successor companies which have not been investigated. Scophony presents an opportunity for full-scale and detailed replication work. Nothing other than an electric motor survives, and

there is no known off-screen photograph of one of these sophisticated electro-mechanical projection systems in operation. This could make a very useful interdisciplinary project for historians and engineers, as the technical insight and knowledge required would be considerable.

Western knowledge of early Russian and Soviet era television history is very patchy, with almost nothing written in the West from primary source materials. It presents an opportunity to study a case of parallel development in a very different societal context. Access to Russian and Former Soviet Union archives is now much easier, and offers the opportunity to increase knowledge and understanding not only of the part Russian émigrés played in the Western developments in television, but also of the parallel path work being pursued in the Soviet Union of the 1920s and 1930s. This could be a fruitful area for co-operation with a Russian university and/or exchange students, and an opportunity to engage with the history of science and technology as practised in Russia.

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