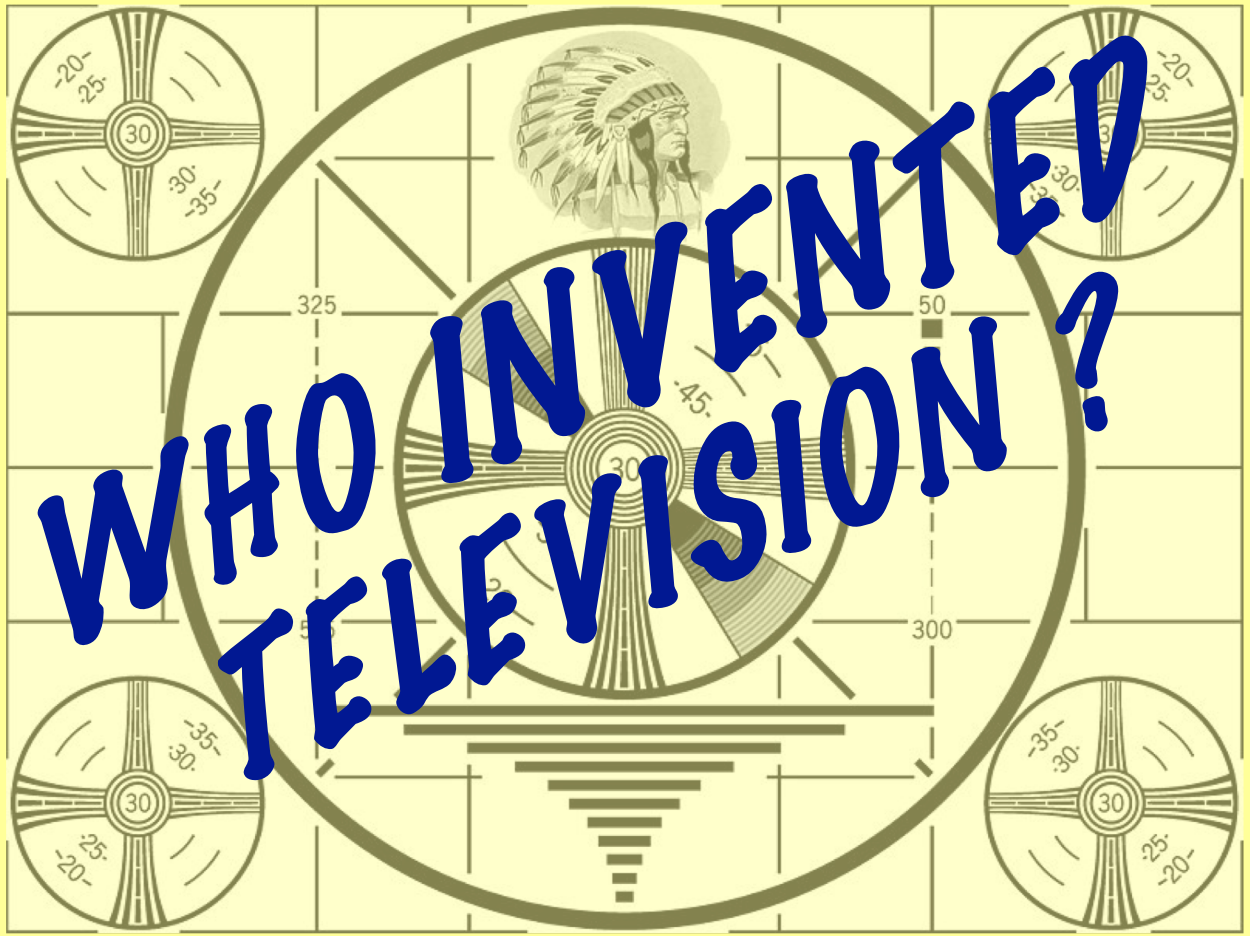
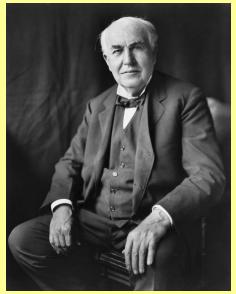
Ottawa Valley Mobile Radio Club
21 October 2020



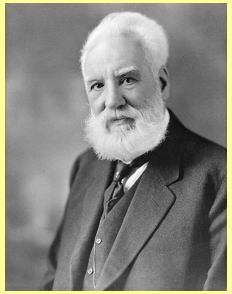
Bryan Rawlings
VE3QN

Great Inventions & Their Inventors …

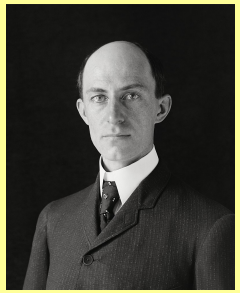
The Electric Light Bulb
Thomas Edison

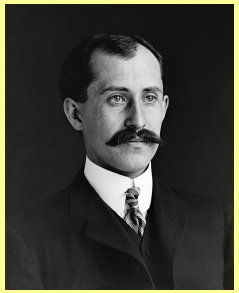


The Telephone
Alexander Graham Bell



The Airplane
Wilbur & Orville Wright





Radiotelegraphy
Guglielmo Marconi

But, who invented Television ?

Paul Nipkow ?

Alan Campbell-Swinton ?

John Logie Baird ?

Boris Rosing ?

Charles Jenkins ?

Vladimir Zworykin ?

Kenjiro Takayanagi ?

Philo T. Farnsworth ?

Karl Friedrich Braun ?

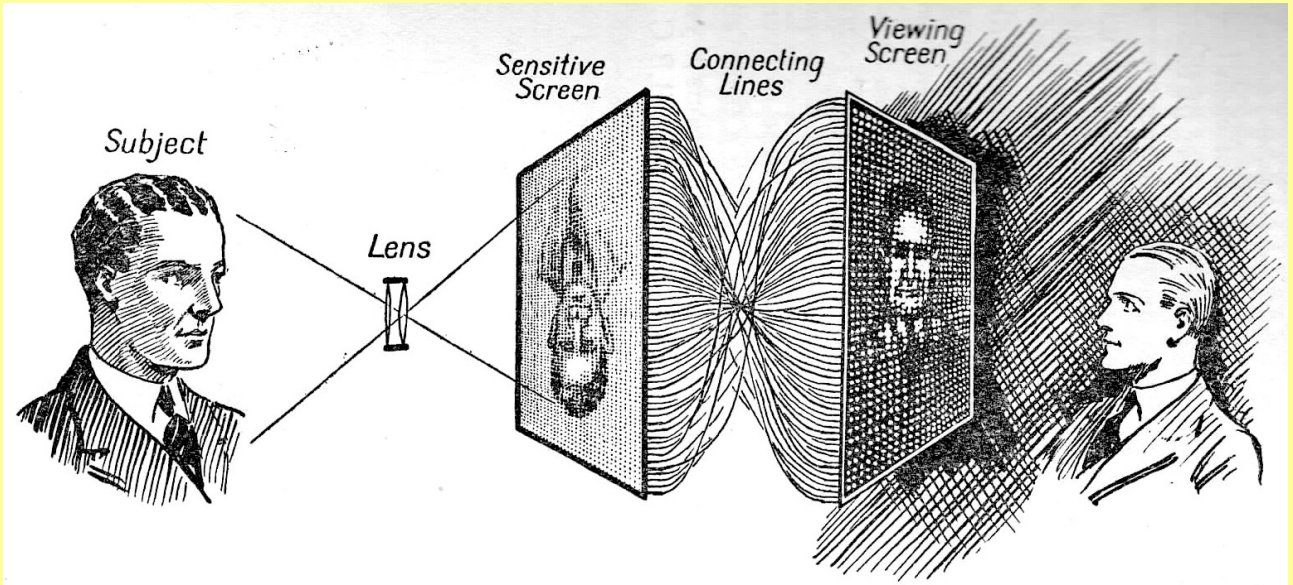
The Origins of Television …

All of these men played a role in the invention of television and in the early decades of the twentieth century there was great popular interest in television.

But the story began late in the nineteenth century …

Conceptualizing Television …

After the invention of the electric telegraph and the telephone some thought that images might be sent electrically by mimicking how images are transmitted from the retina to the brain.



But, clearly, this would be totally impractical. A better idea was needed and Paul Nipkow supplied one …

Paul Nipkow …

Paul Nipkow was born in Prussia in 1860 and worked as an engineer.

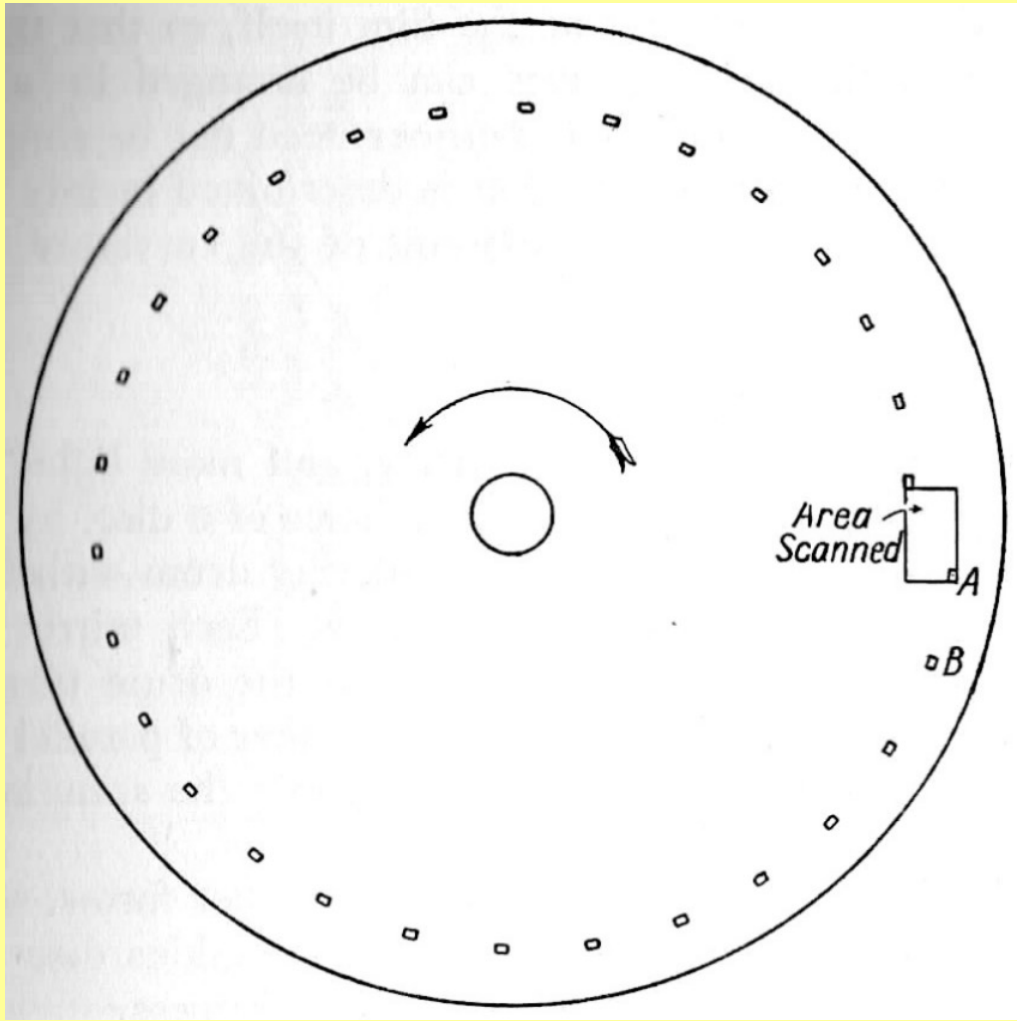
In 1885 he patented an idea for what he called an “electric telescope” but there is no indication he ever attempted to build a device.

Central to Nipkow’s concept was what has come to be called “The Nipkow Disc”.

More significantly, Nipkow could be said to have introduced the concept of “scanning” – central to both mechanical and electronic television.

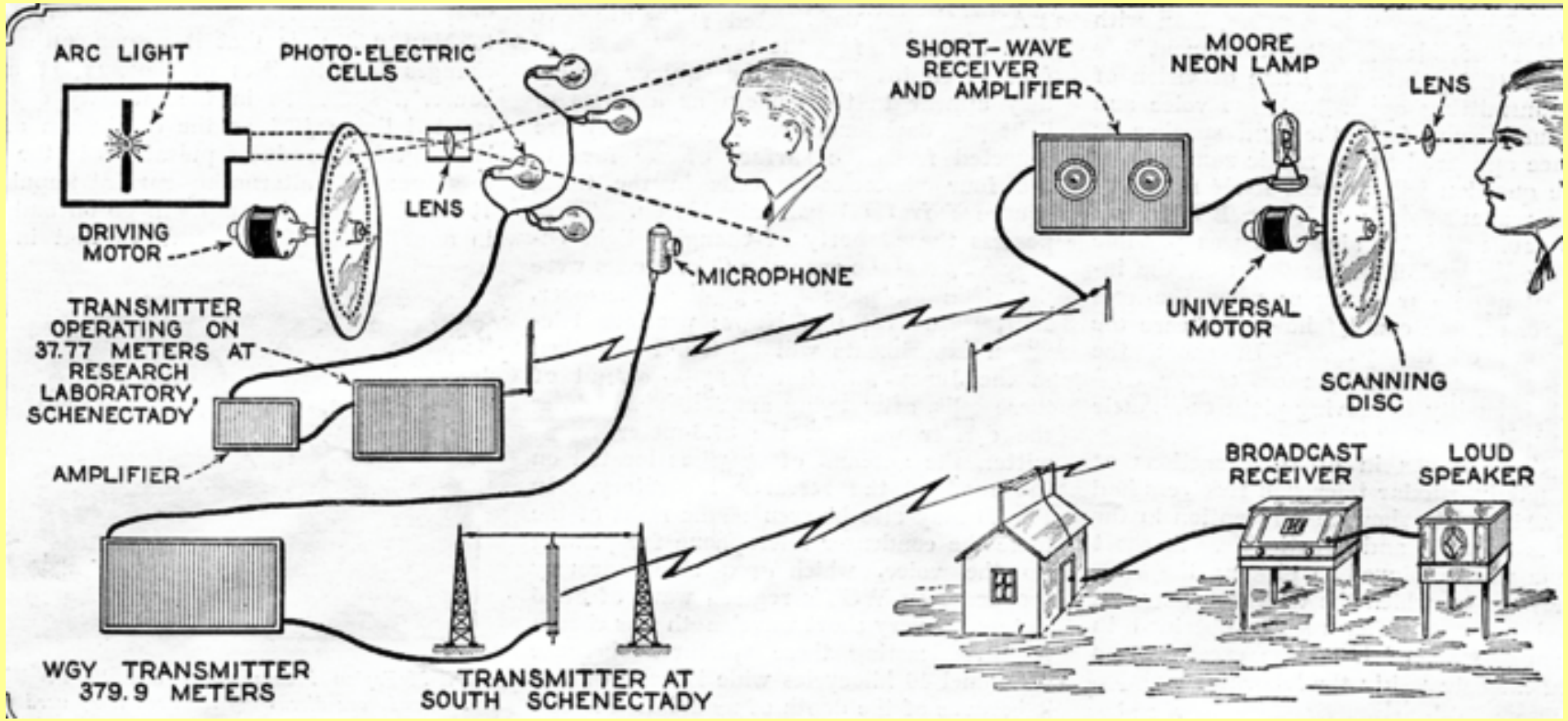
The Nipkow Disc …

- The Nipkow Disc: A circular disc with a spiral sequence of holes.
- A lens focuses an image onto the front of the disc and a photoelectric cell is placed behind the disc. The only light passing through the disc is from the part of the picture revealed through the hole.
- As the disc rotates a single line of the image is scanned; then the next hole appears displaced slightly from the first and scans another line.
- One complete rotation of the disc scans the entire image into as many lines as there are holes. The varying signal from the photocell constitutes the video signal.
- Also, as we shall see in the next slide, the technique can be reversed.



Mechanical Television …

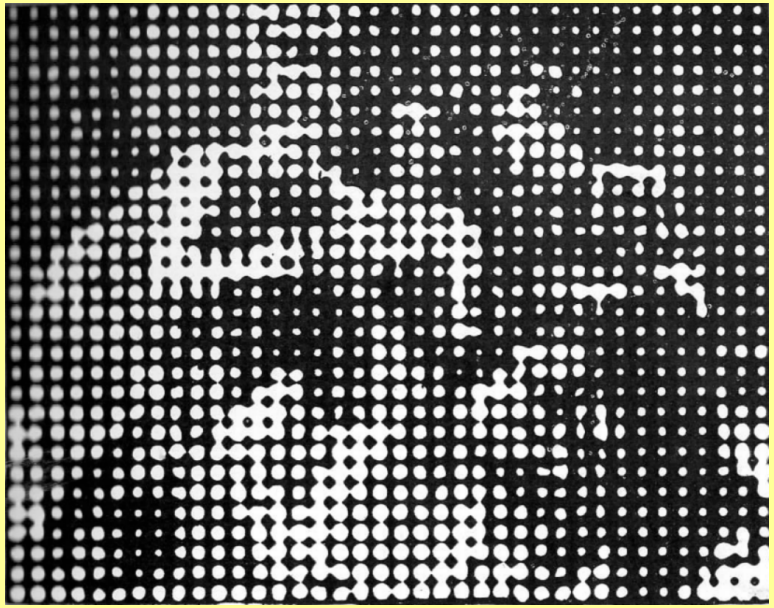
A complete diagram of a mechanical television system based in the Nipkow Disc …



Bandwidth …

An early concern by other users of the radio spectrum was the bandwidth television seemed to need.

A rough calculation of the bandwidth required can be made by estimating the number of pixels in the scanned image, dividing by two and multiplying by the number of frames per second.



This 30-line image with 4:3 aspect ratio and 18 frames/sec. would take up about 11 kHz

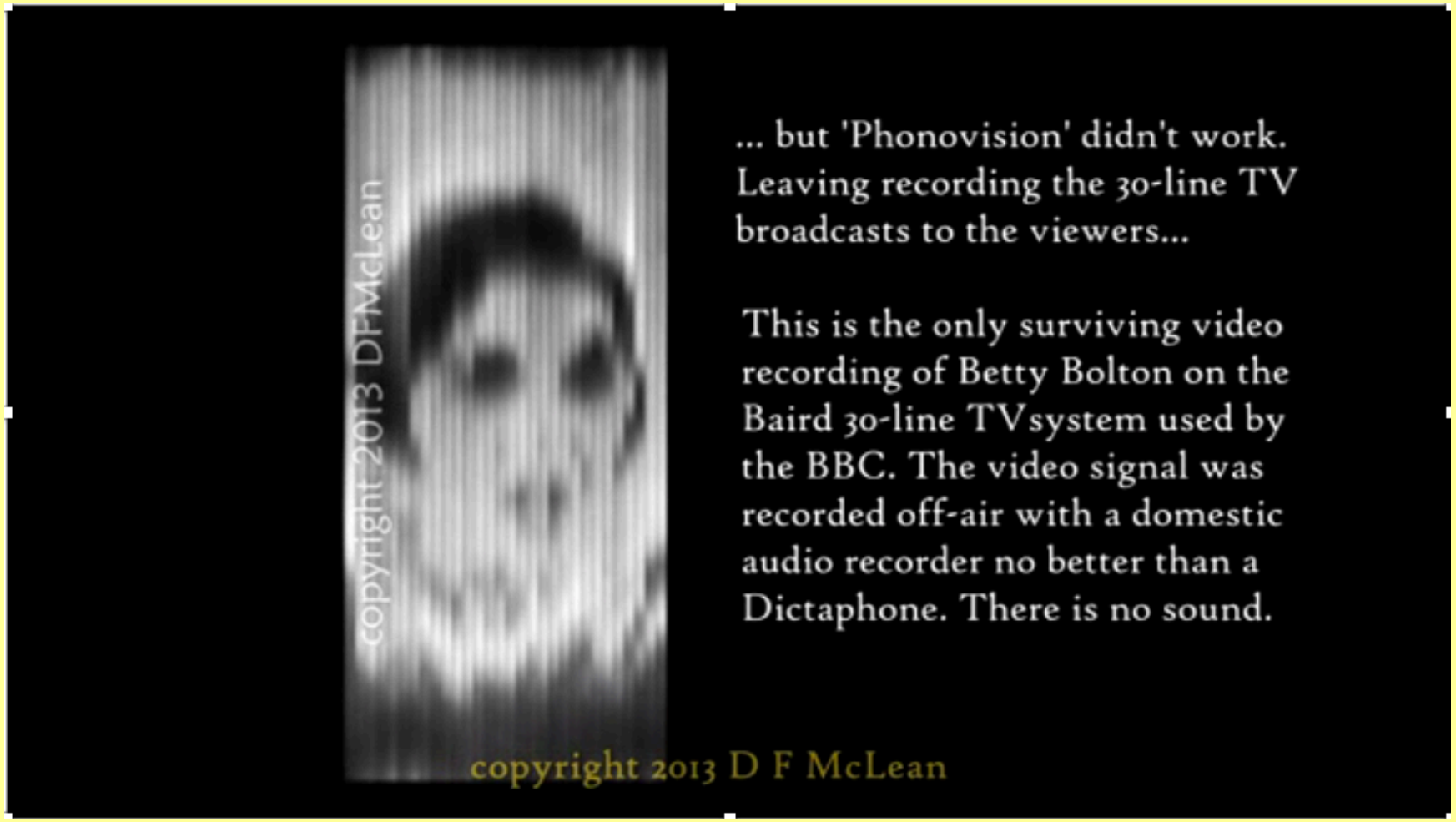
Bandwidth …

An early concern by other users of the radio spectrum was the bandwidth television seemed to need.

A rough calculation of the bandwidth required can be made by estimating the number of pixels in the scanned image, dividing by two and multiplying by the number of frames per second.

But this 405-line image with 4:3 aspect radio and 25 frames/sec. would require 2.8 MHz

How well did Mechanical Television Work?



Television comes to Canada …

VE9EC, an experimental television station owned by the *La Presse* newspaper and radio station CKAC, operated a TV service in Montréal between 1932 and 1940 using 40-line mechanical scanning and receivers with orange-red screens.

John Logie Baird …

Perhaps no name is better remembered among the “inventors” of television than that of the Scottish engineer John Logie Baird.

Baird toiled tirelessly in the 1920’s and 1930’s with mechanical television managing to achieve systems which exhibited 240-line resolution.

Baird was a consummate promoter and had earned quite a reputation in Britain as the “man who had invented television”.

In the 1920’s and early 1930’s he had persuaded a reluctant BBC to allow him to broadcast television programs using 30-line and 60-line mechanical scanners.

The Moment of Truth …

The reaction of the public and of the BBC was that mechanical television would never provide the basis for a public television service. In the meantime, much progress was being made with electronic television and, in particular, with the *Emitron* pickup tube being developed by the British firm EMI (Electric and Musical Industries).

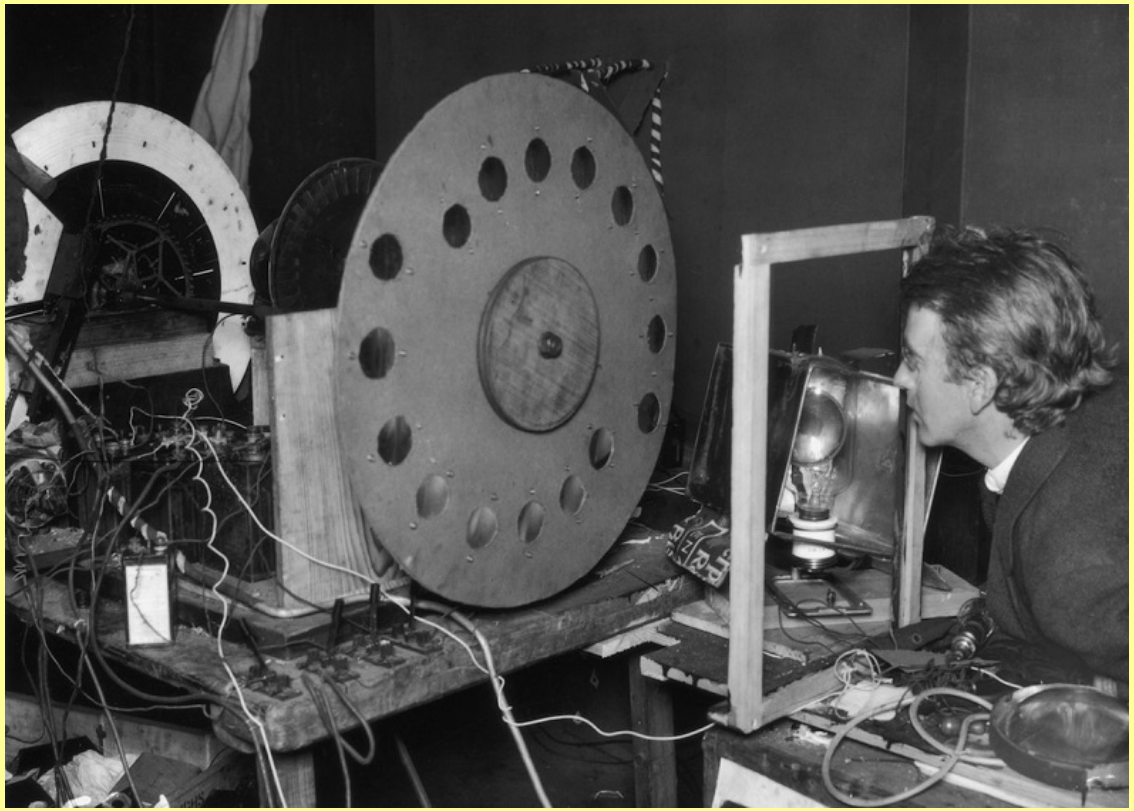
Finally, Baird was allowed to trial his most-advanced 240-line mechanical system alternating with the EMI electronic system when the BBC launched their public television service in the Fall of 1936.

Only when it became clear that electronic methods would eventually prevail over mechanical ones and when the BBC rejected his system did he throw himself into all-electronic systems including the very first colour television demonstration.

The Very Last Spinning Disc …

An evolution of this huge mechanical scanner formed the camera element of Baird's 240-line system which the BBC agreed to trial in 1936 alongside an all-electronic system from EMI.

When, early in 1937, the BBC chose the all-electronic system over Baird's it truly marked the end for mechanical television.

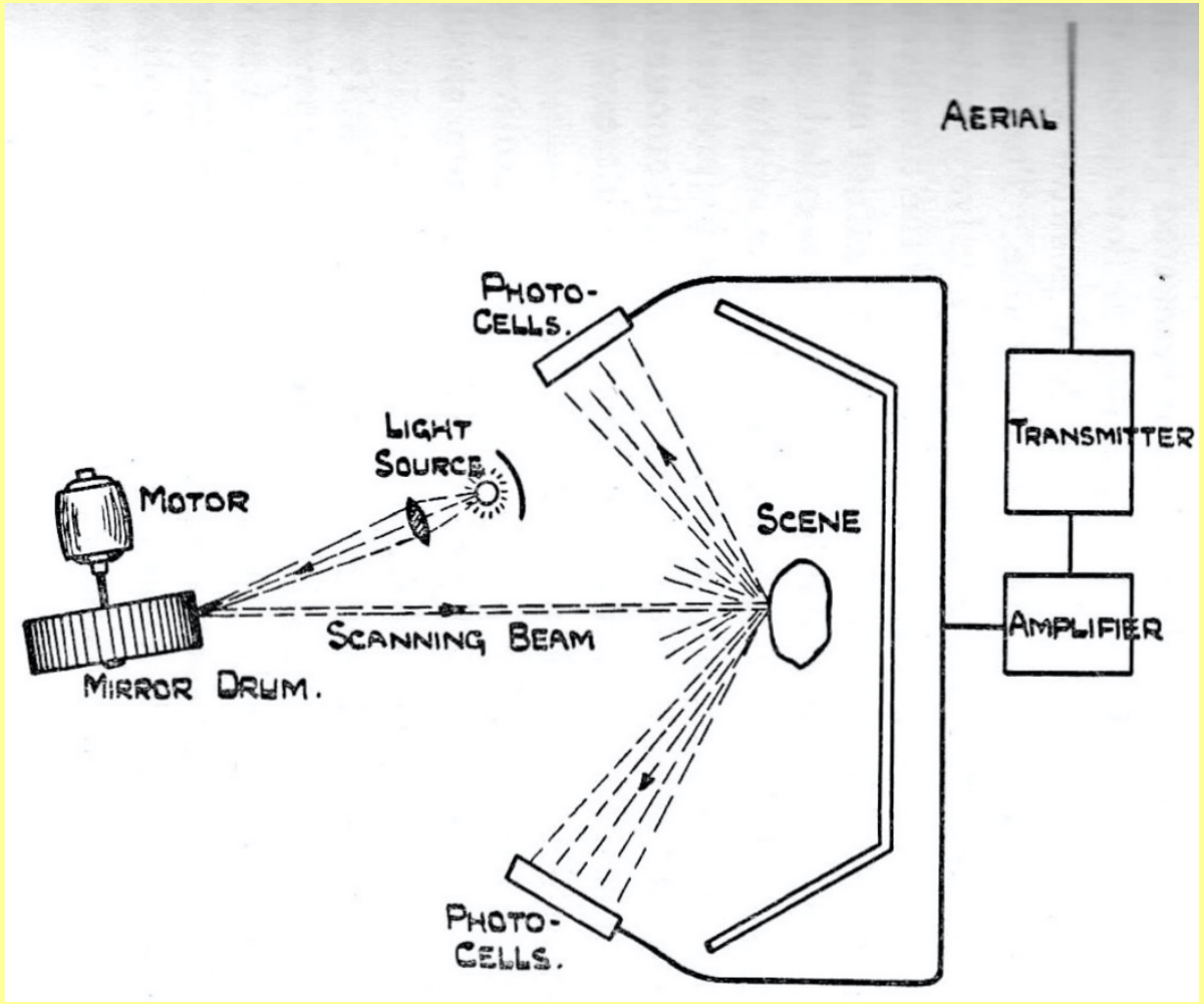


Mechanical Television's Last Chance...

The Flying-Spot Scanner

To get around the central problem with television cameras in the late 1930's – poor light sensitivity – Baird's system also employed this flying-spot scanner method.

The studio would be in the dark – save a low-intensity blue light – and an intense beam of light would be projected on the actors using a rotating drum with tilted mirrors to effect scanning. Banks of photocells in the studio would pick up the reflected light and feed the video transmitter.



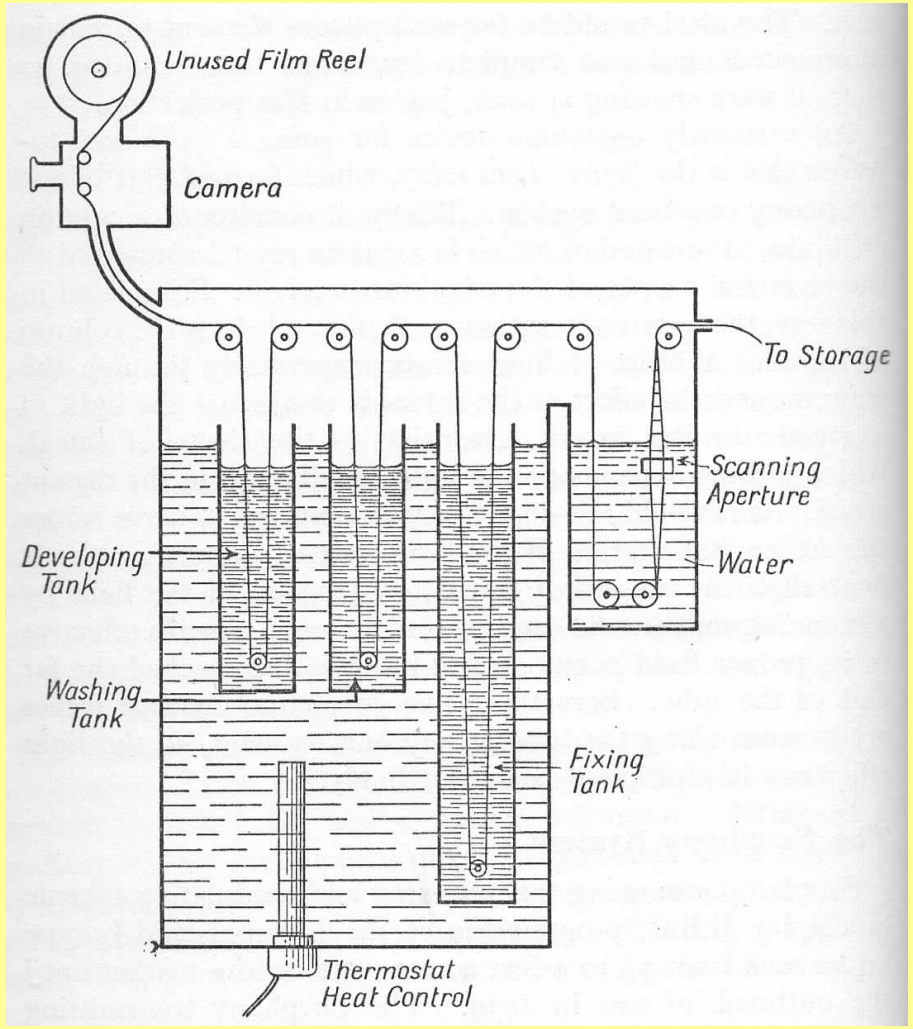
Mechanical Television's Last Chance …

The Intermediate-Film Method

Baird also trialed an Intermediate-Film system of mechanical television such as this.

The Intermediate-Film Method involved filming the scene and passing the exposed film through an in-camera developing lab and then scanning the film while wet to produce the television video.

The audio was delayed and then synchronized using a phonograph recorder-player.



The Electronic Alternative …

So much for mechanical television. Another concept of how television might be accomplished had been brewing for almost as long as the efforts with spinning discs.

In 1908 Alan Campbell-Swinton published an article in *Nature* magazine in which he set out an entirely electronic method of capturing and displaying television employing cathode-ray tubes scanned by magnetically deflecting electron beams.

Hugo Gernsback spelled out Campbell-Swinton's concept of television in an August 1915 article in his popular *Electrical Experimenter* magazine.

Boris Rosing

Russian scientist Boris Rosing had also seen Paul Nipkow's sketch of an "electric telescope" but he doubted television could be accomplished with moving parts. In 1897 he began experimenting on a system based on cathode ray tubes with electrical and magnetic deflection.

In 1907 and 1911 Rosing was granted patents for a system which used cathode ray tubes (based on a design from the German experimenter Karl Friedrich Braun), magnetic deflection and a photocell. While crude, Rosing's system offered the promise of an all-electronic alternative to the mechanical systems then being developed.

Rosing's work caught the imagination of a fellow Russian and pupil, Vladimir Zworykin - and of a schoolboy in Utah.

Philo T Farnsworth …

A true American story, Philo T. Farnsworth was born in 1906 in in a log cabin near Beaver, Utah. His Mormon family moved to a large farm in Rigby, Utah, when he was twelve. In high-school he sketched an idea for an all-electronic television system. While he attended classes at Brigham Young University, he was not allowed to be enrolled because of admission policies and he did not earn a degree.

In 1926 he moved to California and set up a laboratory in San Francisco.

In 1927 he demonstrated the first version of his *image-dissector* pickup tube – all-electronic save for an mechanical generator. By 1929 the *image-dissector* was entirely electronic.

By 1928 Farnsworth had demonstrated live pickup and display of moving images entirely based on electronic devices and with no moving parts.

In 1933 Farnsworth applied for and was granted a patent on his electronic television system.

Philo T. Farnsworth …

Plaque outside Farnsworth's laboratory at 202 Green Street, San Francisco, commemorates the invention of all-electronic television there.

Farnsworth holding his Image Dissector tube

Statue of Philo Farnsworth in the National Statuary Hall, U.S. Capitol Building

Vladimir Zworykin …

While a student in St. Petersburg, Russia, Zworykin worked on electronic television under Boris Rosing. In 1918 he fled the Russian Revolution and emigrated to the United States.

Zworykin was offered a job at RCA by its long-time president David Sarnoff. Sarnoff was determined that RCA repeat with television its phenomenal success with home radio sets where RCA held nearly all the patents and other manufacturers paid them royalties.

A major obstacle was the schoolboy from Utah, Philo T. Farnsworth, who held patents on the concept of electronic television.

David and Goliath:
David Sarnoff & Philo T. Farnsworth

David Sarnoff was the President and CEO of the Radio Corporation of America (RCA). RCA had been phenomenally successful with consumer radio receivers during the recession and the war and was determined to repeat this success with television.

Sarnoff had hired Vladimir Zworykin and was anxious to bring television to America.

In 1930 Zworykin visited Farnsworth in San Francisco where Farnsworth was generous – foolishly so - in sharing information about his *Image Dissector* experiments.

RCA offered Farnsworth $100,000 to buy out his patents. When Farnsworth refused a long legal battle ensued which eventually upheld Farnsworth's patents.

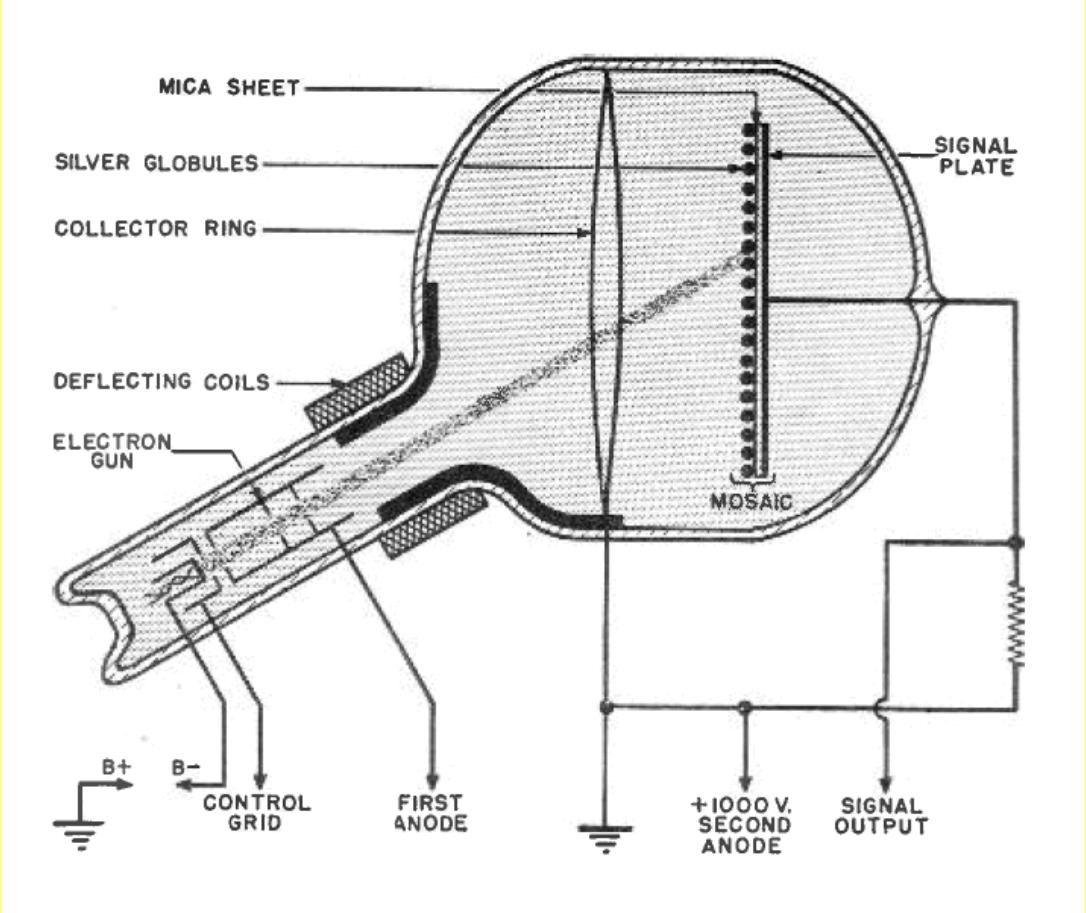
Finally and reluctantly, in the late 1930's, RCA signed a modest licensing agreement with Farnsworth and RCA went on to pioneer the introduction of television in the Americas.

The *Iconoscope* …

An electronic television camera pickup tube based on a concept first patented by Vladimir Zworykin in 1923.

Although Zworykin is credited with bringing the concept to fruition, the *Iconoscope* incorporates work done by many other inventors at the time including Philo Farnsworth.

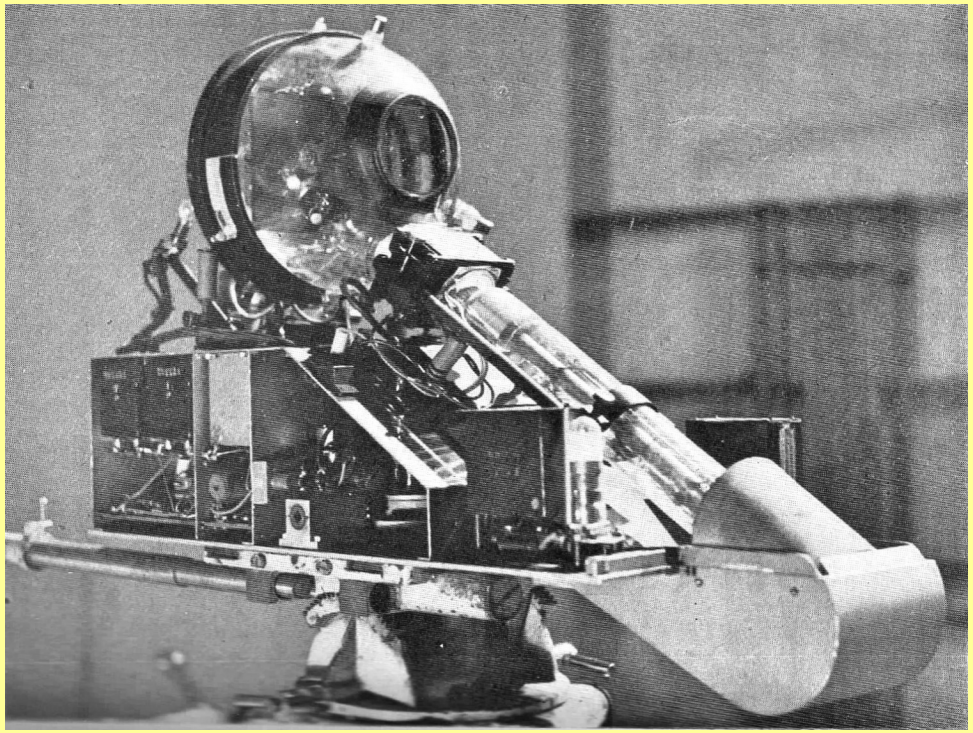
The *Iconoscope* was the principal camera pickup tube used by American television until about 1945. Variations on it were developed by Telefunken and used to televise the 1936 Berlin Olympics. Another variant, the *Emitron*, developed by EMI pioneered the BBC's television service.



Television in the 1930's

A Hybrid of Technologies

- Success with cathode-ray tube displays had largely replaced mechanical television receivers beginning in the 1930's - even for John Logie Baird.
- Baird was even manufacturing CRT's for television in his own factory.
- Electronic pickup tubes, however, were still problematic suffering from low light sensitivity and unexpected anomalies in properly rendering black-and-white images.
- Intense light and bizarre makeup on performers were still required
- Some – especially Baird – thought mechanical pickup systems offered the most promise



Resolution on electronic systems grew from 180 lines to 363 and to 441 lines. By the middle of the 30's it was time to consider launching a public television service …

The Cathode-Ray Tube (CRT) …

While an all-electronic pickup tube struggled with low light sensitivity, more success was being promised from the Cathode-Ray Tube as a display device. The CRT and its use as an oscilloscope had been pioneered in Germany in 1897 by Nobel Laureate Karl Ferdinand Braun.

In 1925 in Japan Kenjiro Takayanagi was experimenting with television using a Nipkow Disc as the pickup device but employing a cathode-ray tube as the display device.

Often called “The Father of Television” by fellow Japanese, he went on to work on colour television and video-tape recorders.

BBC TV Launch – 2 November 1936 …

The World's First Television Station ?

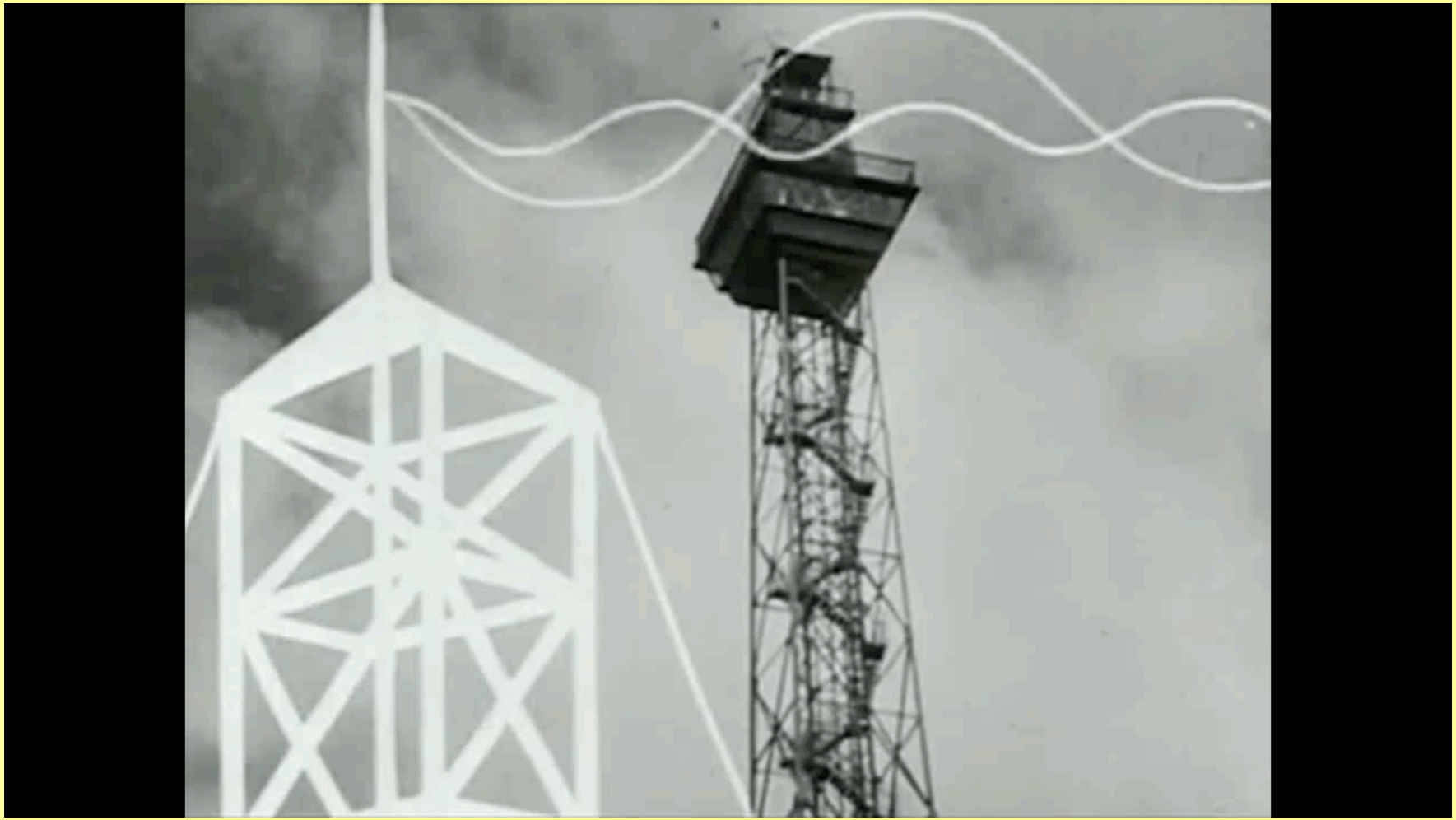
The BBC service from Alexandra Palace, London, bills itself as the world's first high-definition television station.

It was known, however, that Nazi Germany had launched a TV service a year earlier but relatively little was known about it.

However, in 1990 after German re-unification, several reels of kinescope recordings from the Berlin station were discovered in a vault in East Germany.

Paul Nipkow Television Station Berlin …

Launch March 22, 1935



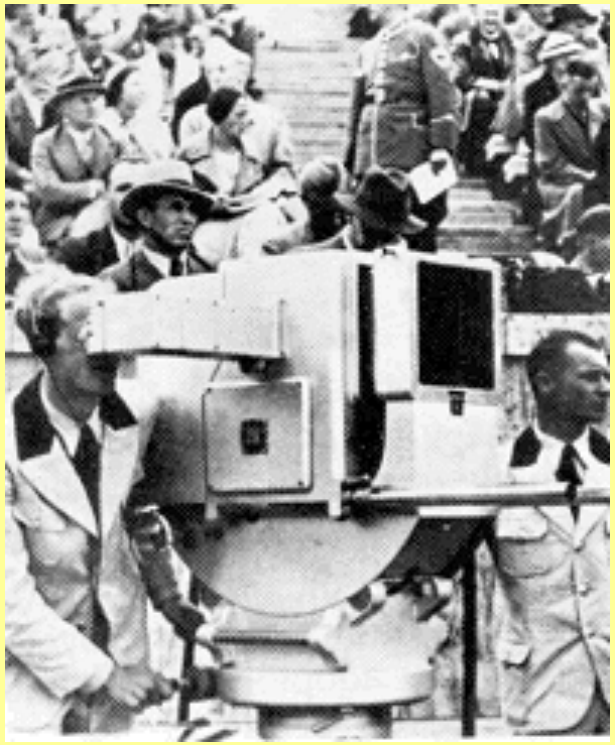
The Berlin Television Station …

The Berlin station operated on 39 MHz and had a resolution of 180 lines.

Unlike the BBC service launched a year later, the service was not aimed at sets sold to citizens. Rather, television "parlors" were set up throughout greater Berlin where people could watch television programs.

The principal attraction was the 1936 Berlin Olympics which were televised using cameras such as these equipped with Telefunken *Superikonoscope* pickup tubes.

The Paul Nipkow station operated throughout the War but was destroyed in its closing days.



World War II Halts BBC-TV …

Britain declared war on Germany on September 3rd, 1939.

Fearing that a 16 kW video signal from central London on 45 MHz would guide enemy bombers to their target, authorities ordered BBC TV to shut down immediately.

The station went off the air in the middle of playing a Mickey Mouse cartoon.

Seven years later, the war over, the station which had not been badly damaged in the war started up again and resumed by playing the rest of the cartoon!

Early Television Standards …

Comparison of the early television standards employed by …

- BBC TV Alexandra Palace London from 2 November 1936
- WNBT (ex W2XBS) New York from 1 July 1941

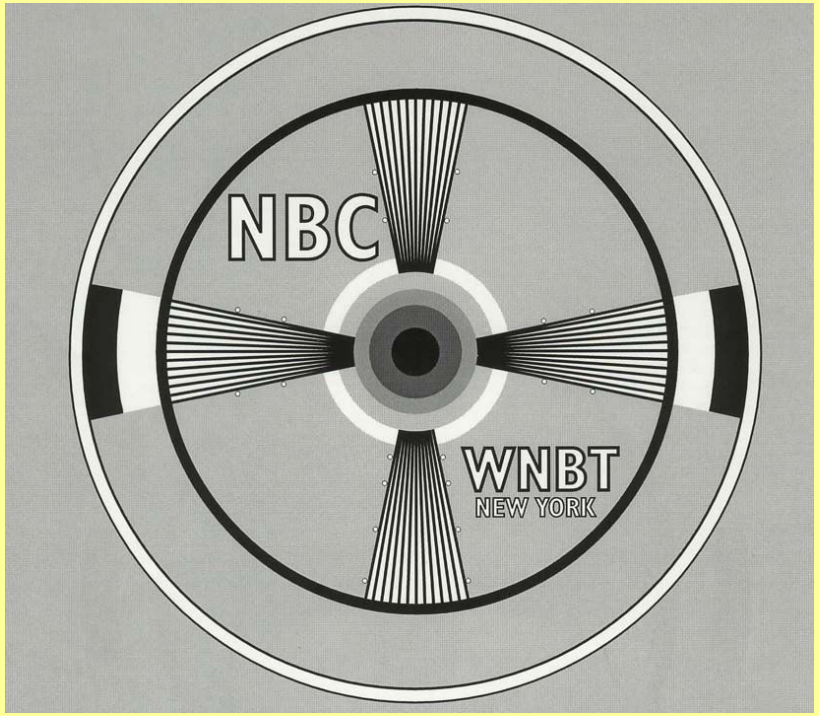
	BBC TV	WNBT
Resolution (lines)	405	525
Frames/sec	25	30
Fields/sec	50	60
Aspect Ratio	5/4	4/3
Modulation Sense	Positive	Negative
Video Bandwidth	±3 MHz	+4.2 MHz
Emission Type (Video)	AM dbl sideband	AM Vestigial USB
Emission Type (Audio)	AM dbl sideband	FM
Audio Bandwidth	±15 kHz	±25 kHz
Video/Audio Separation	-3.5 MHz	+4.5 MHz
Video Carrier	45.0 MHz	51.25 MHz
Audio Carrier	41.5 MHz	55.75 MHz
Polarization	Vertical	Horizontal

Television Launches in the U.S. …

The legal struggle between RCA and Farnsworth over, commercial television in the U.S. launched on July 1st, 1941 as RCA experimental station W2XBS became WNBT, Channel 1, in New York.

About two hours later the CBS station WCBS-TV launched in New York on Channel 2.

Unlike in the U.K., the few television stations operating in the U.S. as the U.S. entered World War II in December 1941 continued to operate; however, investment in television and the manufacture of sets halted.



Postwar Television …

Analogue Television standards 1946 +

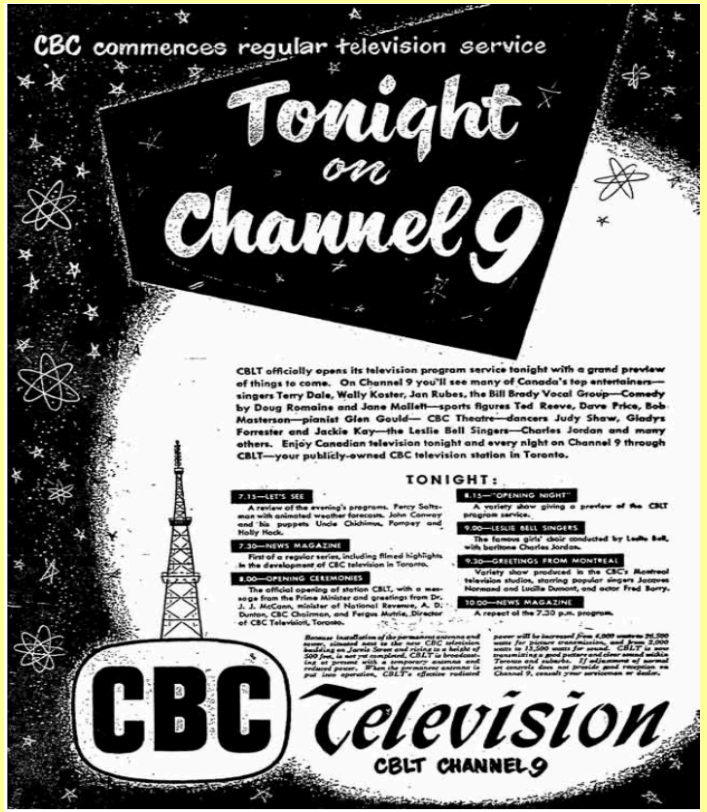
	U.K.	NTSC	CCIR	France
Resolution (lines)	405	525	625	819
Frames/sec	25	30	25	25
Fields/sec	50	60	50	50
Aspect Ratio	4/3	4/3	4/3	4/3
Video Modulation	Positive	Negative	Negative	Positive
Video Bandwidth	±3 MHz	+4.2 MHz	+4.2 MHz	+10 MHz
Emission Type (Video)	AM Vestigial LSB	AM Vestigial USB	AM Vestigial USB	AM Vestigial USB
Emission Type (Audio)	AM dbl sideband	FM	FM	AM dbl sideband
Audio Bandwidth	±15 kHz	±25 kHz	±25 kHz	±15 kHz
Video/Audio Separation	-3.5 MHz	+4.5 MHz	+5.5/+6.5 MHz	±11.15 MHz
Channel Width (MHz)	5	6	7/8	14
Antenna Polarization	Vert/Horiz	Horizontal	Vert/Horiz	Vert/Horiz

- NTSC standards were used in the Americas, Japan, the Pacific and SE Asia
- The CCIR standards were in use mostly worldwide with many variations
- The U.K. system was used in the U.K. and Ireland but CCIR standards were introduced in 1964 and the last 405-line transmitter was finally shut down in 1985
- The French system was in use in France, Belgium, Luxembourg and Monaco. In the 1960's France switched to the 625-line CCIR system with, however, several significant variations

Television comes to Canada (again)…

CBFT Montréal
6 September 1952

CBLT Toronto
8 September 1952



CBOT Ottawa
2 June 1953

75 Years of Analogue Television …

The NTSC television standards defined analogue television in the Americas and elsewhere from the early 1940's to early in the 21st century.

There was one major enhancement and several minor upgrades – all of which maintained backward compatibility. These were …

- Colour television (1954)
- Stereo sound (in the 1960's)
- Closed captioning
- Anti-ghosting signal (2000's)

The U.S. switched all full-time broadcasters to digital television in 2009 - as did Canada in 2011. In the U.S. low-power and community stations were permitted to continue using analogue. In Canada analogue television continued in certain smaller markets.

The Arrival of Colour …

- "NTSC" colour system launched in the U.S. 1 January 1954
  - Colour camera produced three video signals in Red, Green and Blue
  - Colour receivers originally used a three-gun CRT with a shadow mask directing beams to red, green and blue phosphors
  - Backwards compatible with existing black & white receivers
  - All information fitted into existing 6 MHz channels
  - "Luminance" signal carried on the basic video carrier
  - "Chrominance" signals carried by two signals 90° phase-shifted on a suppressed carrier 3.58 MHz above the video carrier
- European Colour System (PAL)
  - Essentially the same as NTSC but with a 4.43 MHz chrominance signal
  - Colour phase was reversed on alternate lines
    - "PAL" = "Phase Alternation by Line"
- SECAM – French Colour System
  - "*Séquential Couleur à Mémoire*"
  - The chrominance carrier is frequency modulated and uses a one-line delay line

Transition to Digital Television …

- The ITU is spearheading a worldwide transition to digital television
  - Digital television is accommodating …
    - Higher resolution 1125-lines (1080i)
    - Multiple video formats (480i, 720p, 1080i, 1080p
    - Widescreen displays 16:9
    - Multi-channel digital sound
    - Multiplexing several programs onto one channel

- There are two major digital television standards …
    - Advanced Television Standards Committee (ATSC)
    - Digital Video Broadcasting (DVB)

So, Who Invented Television ?

Paul Nipkow

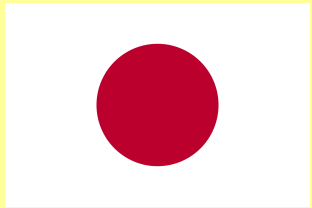
?

John Logie Baird

Philo T. Farnsworth

Boris Rosing

?



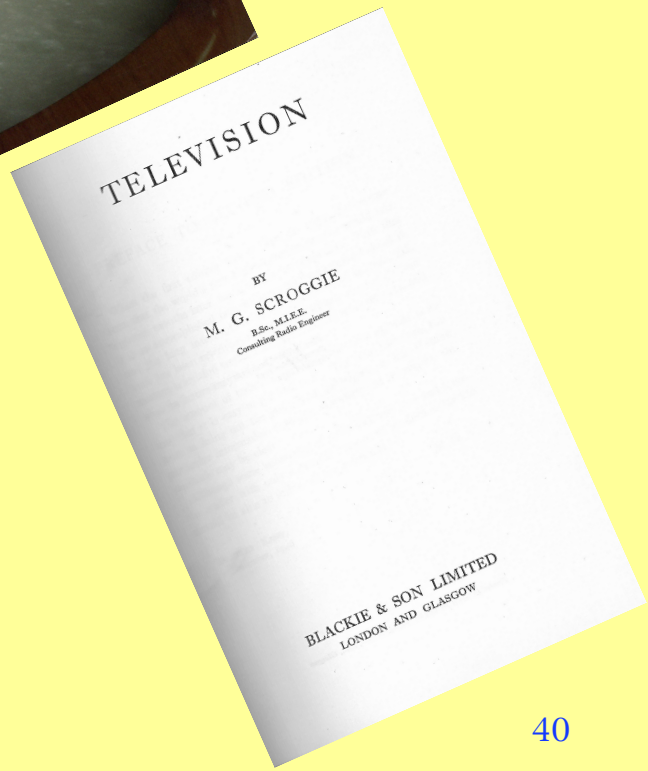
Kenjiro Takayanagi

Sources …


Philo T. Farnsworth vs David Sarnoff in
THE LAST LONE INVENTOR
A TALE OF GENIUS, DECEIT, & the Birth of Television
Evan I. Schwartz


JOHN LOGIE BAIRD:
THE MAN WHO INVENTED TELEVISION
Bob Greenlee


IMAGES ACROSS SPACE
THE ELECTRONIC IMAGING OF BAIRD TELEVISION
Dr Douglas Brown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Thank You !