Colour tv goes public

Ray Herbert recounts events surrounding the first public demonstration of colour television in 1938.

On 4 February 1938, an audience of 3000 people watching a film at the Dominion Theatre in Tottenham Court Road, London had no idea that they were about to witness a piece of television history.

During the interval they were surprised to see live colour television pictures on a 12 by 9 feet screen, transmitted from a small studio at the base of the Crystal Palace South Tower. Advance publicity of the event had been impossible due to the restrictions imposed by the authorities regarding experimental wireless transmissions.

This was a highly significant occasion in two respects; never before had colour television been demonstrated to the public or transmitted by radio link – a double first for John Logie Baird.

Bearing in mind the many months of development work and the high cost of the sophisticated projection equipment, it is remarkable that no further demonstrations took place. A possible explanation is that Baird wanted to start work on a 600-line, high definition colour system and this he demonstrated in December 1940 (*Wireless World* February 1941).

Earlier experiments

It was typical of John Baird's zeal for immediate progress that he should attempt to produce television pictures in colour during 1928, at a time when improvements in the quality of the existing monochrome images represented the real priority. At that time he used scanning discs at the sending and receiving end which had 15 holes in three separate spirals, each occupying a third of the circumference and covered sequentially with red, green and blue gelatine colour filters.

The discs span at 600rev/min providing ten images a second. It was a relatively crude arrangement but the highly regarded journal Nature reported enthusiastically, "The colour images we saw in this way were quite vivid. Delphiniums and carnations appeared in their natural colours and a basket of strawberries showed the red fruit very clearly."

Having achieved a notable first, Baird moved on to the more prosaic problems of setting up studios and equipment for television broadcasts.

Colour updated

The later colour work carried out by Baird had it's beginnings at the Dominion Theatre in 1936 when he demonstrated his monochrome multimesh system. Whether by accident or

Supplying power

Power for the 150A arc lamp came from a Hackbridge Hewittic mercury arc rectifier and a frequency changer provided 100Hz for the synchronous motors.

A cubicle immediately adjacent to the colour projector housed the drive amplifiers and their associated power supplies. The final stage used two high power triodes in a patented, push-pull arrangement to deliver the 20000 volts peak-to-peak, necessary to exercise full control of the Kerr cell from darkness to full white illumination.

Twenty-faceted mirror drums for the mechanical colour camera and projector as used in for the Dominion theatre demonstration in December 1937 and February 1938. Photographed by Richard Brice.

design, it turned out that this arrangement could very easily be adapted for colour transmissions. This method was an elaboration of his earlier experiments with interlaced scanning in 1925. Then he used a scanning disc with two spirals of eight lenses so positioned that they produced an interlaced image. Fortunately, most of the apparatus survived and is in the Falkirk museum.

At the Dominion Theatre a 20-facet mirror drum in conjunction with a slotted disc provided a basic 40-line interlaced scan which was then repeated three times, in each case being laterally displaced to mesh with other fields to provide a final frame of 120 lines.

An arc lamp provided the illumination and a Kerr cell acted as a light valve to produce the necessary variations in light and shade. This arrangement had been used to good effect in 1932 to show large television picture of the Derby from the Epsom racecourse on the screen at the Metropole Theatre.

Baird only needed to place colour filters over the slotted disc apertures to convert this equipment into a two-colour television system.

The colour projector

Ideally, the light path would have been in a straight line, but due to lack of space at the theatre behind the translucent screen used for back projection, this could not be achieved. Consequently, the light source, rotating colour filters and Kerr cell had to be housed in a separate cubicle at the side of the main mirror drum unit. This caused unwelcome complications in regard to the need for extra mirrors, an additional synchronous motor and mechanical phasing arrangements.

A 150A automatic searchlight arc lamp fulfiled the function of a constant intensity light source. Water cooling of the aluminium panels in front of, and above the arc, proved to be essential. A condenser followed by an intermediate lens, focused the light beam on to a disc having 12 slots covered alternately with blue-green and red colour filters. It then passed to the Kerr cell – a key component in the provision of large screen television pictures. Invented by a Scottish scientist in 1875 it consisted of electrodes immersed in nitrobenzine.

When polarised light from Nicol prisms traversed the cell, the intensity could be controlled by applying a variable polarising voltage to the electrodes. The higher the voltage the greater the illumination. In this installation the Kerr cell had just two electrodes to avoid loss of light and they were connected to a pair of transmitting triodes operating in push-pull. Due to the heat contained in the two-inch diameter beam of light, conventional Nicol prisms could not be used. They were replaced by polarising prisms of special and patented design, cut and polished from the largest piece of pure calcite crystal which could be obtained.

The light path now had to be switched to a vertical plane using a mirror, so that it could be directed on to a 12in diameter duralumin drum containing 20 small mirrors, each inclined successively at slightly differing angles. This mirror drum revolved at the high speed of 6000rev/min, driven by a two-pole synchronous motor operating from a 100Hz supply. The mirrors had to endure very considerable centrifugal forces and for safety reasons were secured by high tensile steel clamps and screws.

A large translucent screen displayed the colour pictures projected from the mirror drum. Frosted glass would have been too directional for cinema use and the screen consisted of Japanese silk, stretched and doped.

Studio equipment

During the mechanical era of television, two main methods of transmission were available. The floodlight system was used by Baird from the earliest days until 1928. The person to be televised stood before a bank of floodlights and a lens focused an image of the scene on to a disc having 30 holes or lenses. A photocell recorded the light variations in the 30 vertical segments.

The spotlight arrangement used between 1929 and 1935 for the first public television service called for the performers to be in a completely dark studio. Through a hole in the wall a mirror drum scanner projected a sharply focused beam of brilliant light which scanned the subjects in sequential vertical strips. Banks of photocells detected the level of reflected light.

For the colour demonstration, Baird had reverted to the floodlight method. Electronic colour cameras had not yet arrived, and in the USA and this country, mechanical devices using rotating colour filters, prevailed.

The colour camera, or scanner, was mounted on a rubber-wheeled truck and quilted material over the casing helped to reduce the mechanical noise. A 20-facet mirror drum, similar to that used in the projector but reduced in size to 8in, rotated at 6000rev/min directing slices of the televised scene to the slotted, colour filter disc.

The coloured segments were presented sequentially to a Baird multiplier photocell having a rubidium cathode. This eight-stage multiplier, using the Weiss principle of secondary emission amplification, enabled gains of 10000 to 20000 to be achieved without the twin problems of instability and microphony which were often experienced with thermionic valve amplifiers.

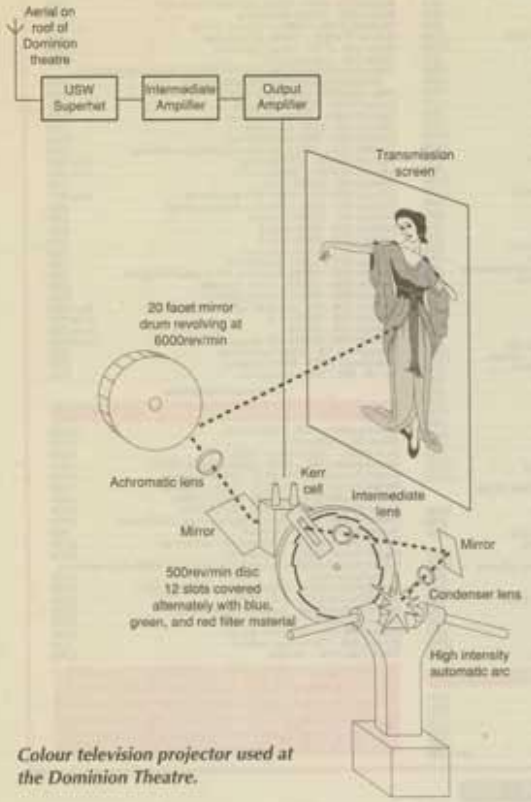
The choice of a rubidium photocell appears to be unusual but the reason could be found in a report of discussions following a paper read by J C Wilson on colour television. Baird, who chaired the meeting, recalled that during his experiments, red and blue fabrics were indistinguishable on the receiver screen and it turned out that the photocells in use were responding equally to the infra-red radiation from these objects instead of the light. Rubidium photocells proved to be relatively insensitive at the infra-red end of the spectrum and this overcame the problem.

Both the colour camera and projector were manufactured at the works of B J Lynes Ltd, from drawings supplied by Baird's staff.

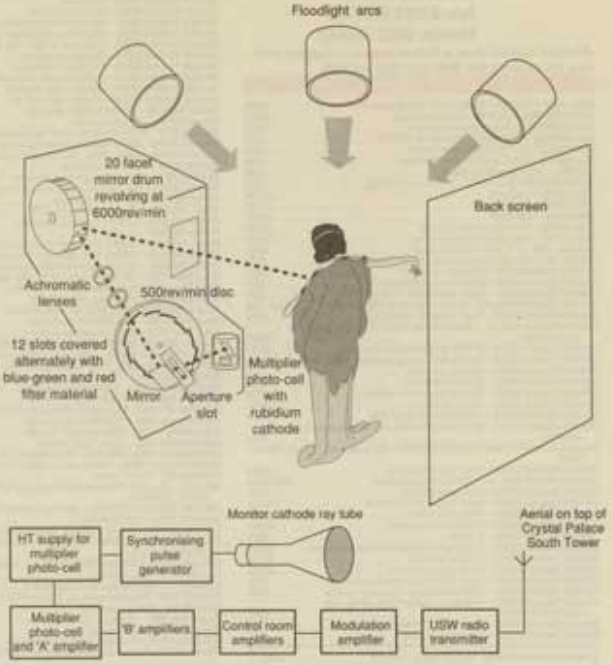
Results

With a definition of only 120 lines the pictures

Dominion theartre colour television projector at Baird's private laboratory in Sydenham, 1937. Mid-left is the arc lamp and above it its vent. To the right of the lamp housing, and slightly lower, is the rotating colour filter, lens and fixed mirror assembly. From the fixed mirror, the light shone upwards into the rotating mirror drum above. Photographed by Richard Brice.



Colour television projector used at the Dominion Theatre.



Mechanical colour camera and studio arrangements at the base of the Crystal Palace South Tower.

lacked the clarity of the BBC 405-line service and with a low frame frequency of 8.5 per second, flicker was noticeable. The expected shortcomings of a two-colour system did not materialise and the picture had a perfectly acceptable colour balance.

Daily Telegraph radio correspondent, L Marsland Gander, attended the demonstration with Lord Selsdon, Chairman of the Television Advisory Committee and Dr Clarence Tierney, the Television Society Chairman. He reported "I shared the opinion expressed to me by Dr Tierney that the colours, whatever the deficiencies of definition, were more natural than those of most colour films."

It is remarkable that this important contribution to the progress of colour television resulted from the efforts of a small team of four people working in a converted stable in Sydenham. Baird continued with his colour experiments during the war with an even smaller staff and demonstrated 500-line stereoscopic colour television in 1941. Then followed the first multi-gun colour picture tube in 1944.

I would like to thank Paul Reveley for his help in preparing this account and Richard Vince, another member of Baird's staff, who kindly provided the photographs. ■

Baird's later colour work

Encouraged by what could be achieved using only two colours, John Baird set out to demonstrate high-definition pictures of 600 lines.

Spotlight scanning was used in the studio with rotating colour filters and photocells to detect the level of reflected light. At the receiving end, a projection cathode-ray tube produced a black and white picture, colour being added by another rotating colour filter having equal segments of blue-green and red. With this arrangement a large, bright picture measuring 2 by $2\frac{1}{2}$ feet could be obtained.

This unretouched photograph of Paddy Naismith, a visitor to the press demonstration, was taken direct from the screen of Baird's projection colour receiver in December 1940 on Dufaycolor film. It subsequently appeared in the April, 1941 issue of *Electronics and Television.*

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Courtesy of Steve Dichter