22.3 SINGLE TUBE COLOUR CAMERA

Colour Dissector Systems

From the early days of colour television search for a methods of obtaining red, green and blue signals from a single camera tube has continued, to make the cameras compact, portable. Single tube cameras avoid the problems of registration of colours and equalisation of the signals by providing three matched sets of circuits. A number of colour dissector systems have been developed to separate the primary colours using a single pickup tube, with target split into tiny areas or stripes from which the primary colours could be read sequentially. A Sony system employs *vertical stripe filters* with or red, green and blue stripes, while a JVC system uses a sequence of green, cyan and white (clear) stripes. Some Panasonic and JVC cameras make use of *crossed or angular stripes* of yellow and cyan, or yellow and magenta combinations. In another system, the vertical stripes filter comprises stripes in a sequence of green, cyan and white (clear) colours. Each system has its own specific readout decoding to obtain the primary colour signals.

Trinicon

In this colour saticon pickup tube developed by Sony Corporation, a *built-in colour filter* consisting of sets of Red, Green and Blue stripes of uniform pitch is used to disassemble an object into an optical image of three primary colours. The 2/3 in. Saticon Mixed Field (SMF) Trinicon tube give a high performance close to that of three tube cameras. However, compared to three tube cameras in which all the light is diverted by the dichronic prism surfaces to the three colour sections, the incoming light is partially absorbed in the filters, limiting its use in higher illuminations.

If the electron beam scans the charge image formed on the target, due to light passing through the colour filters, the R, G and B colour signals are obtained one after the other from the target, by generating an electronic index signal at the target. This signal is used to demodulate the phase of the carrier frequency generated by the stripe filter. The *index signal* is produced by a set of electrodes which modulate the target voltage, line by line, and this in consequence modulates the video signal. The index signal is recovered by a *one line comb filter.* Fig. 22.6(a) illustrates how the signal is formed in the tube.

During phase separation, the colour signals are determined time elapsed from the starting of the scanning. The frequency component of each colour signal is the same, though the colour cannot be obtained directly. An *indexing signal* used as a phase reference to decode the multiplexed colour signal.

The *structure of target* for phase separation by indexing is shown in Fig. 22.6(b). The stripe filter consists of repetitive sets of red, blue and green primary colour stripes and is located near the face plate. It is arranged inside the tube face plate with a set of transparent conductive Nesa stripes behind a sheet of insulating glass layer as shown followed by the photoconductive target plate.

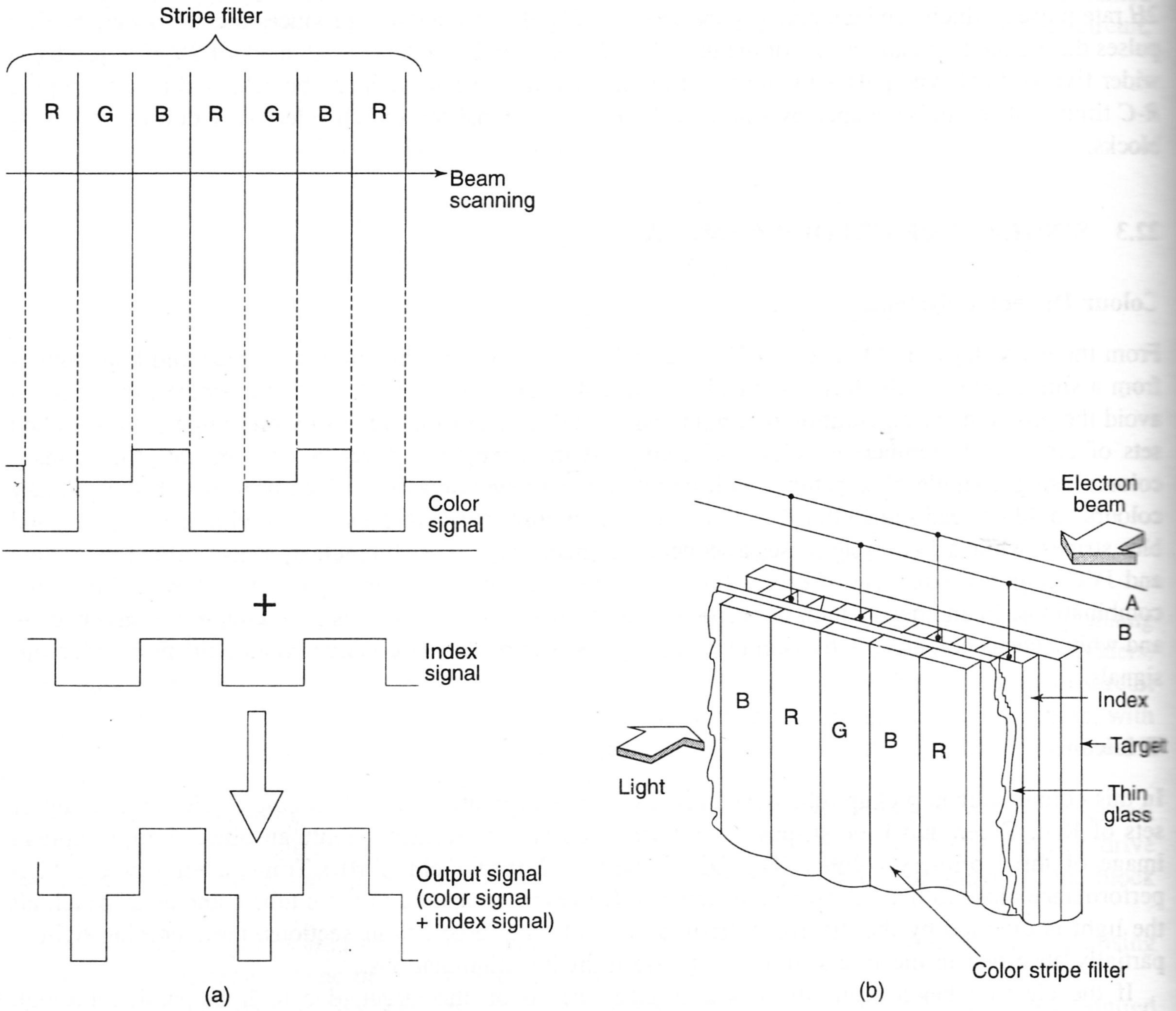


Fig. 22.6 (a) Phase separation by indexing, (b) Structure of target (*Courtesy:* Sony Corp.)

The *Nesa* film is composed of transparent conductive *comb-shaped stripes* as shown in Fig. 22.7. A set of R, G and B stripes corresponds to the indices A and B. An offset pulse (square wave) which is reversed every horizontal scanning period, as well as the DC target voltage *Vt*, is fed to indexing electrodes A and B through the drive transformer.

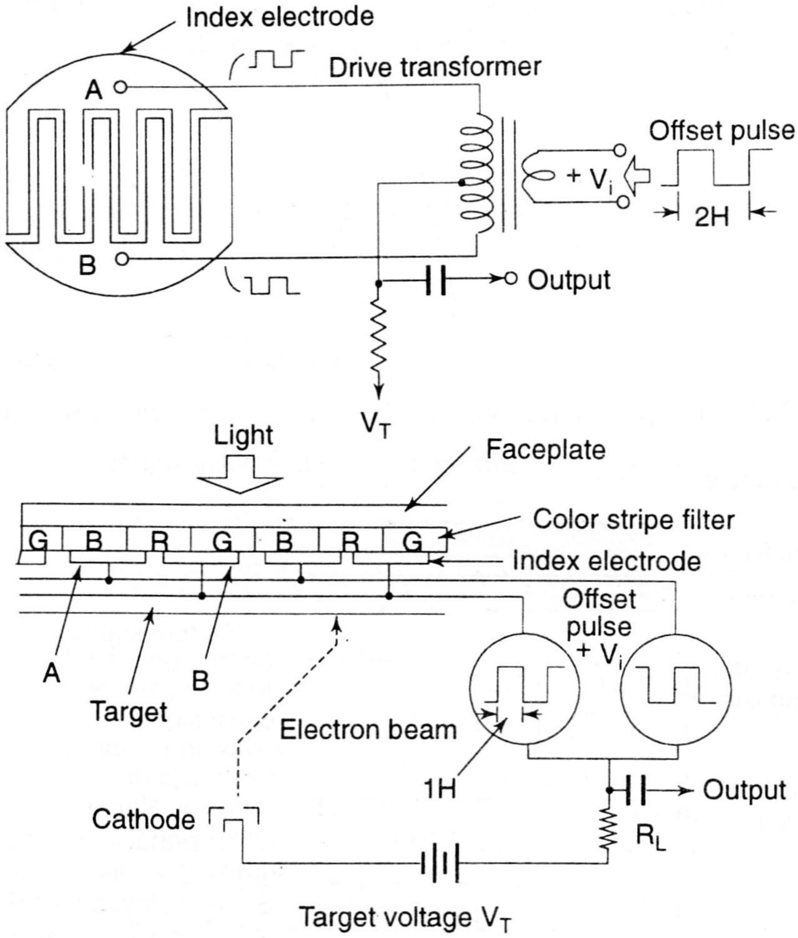


Fig. 22.7 Indexing electrodes and the comb shaped stripes (Sony Corp.)

The frequency of the signal from saticon depends on the number electrodes *A* and *B*, and the horizontal scanning rate of the electron beam. The number of pairs of indexing electrodes is determined so that frequency is the resolution limit viz. 4.5 MHz. The pitches of the indexing electrodes and the stripe filter are the same. If a small dark current flows through saticon the indexing signal can be satisfactorily obtained.

The optical image obtained on the target through the lens system, is optically colour modulated via the colour stripe filter. Phase modulation is accomplished by three primary colours as the beam scans it. A colour subcarrier frequency signal, which has amplitude proportional to the light intensity and the indexing signal are multiplexed and obtained by the indexing electrodes A and B. The frequency of the multiplexed signal is 4.5 MHz, and is the same as that of the indexing signal, as illustrated in Fig. 22.8. The advantage of the method is that high resolution can be obtained because the high band's range can be expanded as seen in the illustration.

Dissection Technique

The technique of dissection of the colour signal from the subcarrier frequency is shown in Fig. 22.9(a). If green monochrome light is incident on the target only green light can pass through the stripe filter during nth horizontal scanning. At that time, indexing signal 'b' and the colour signals are multiplexed,

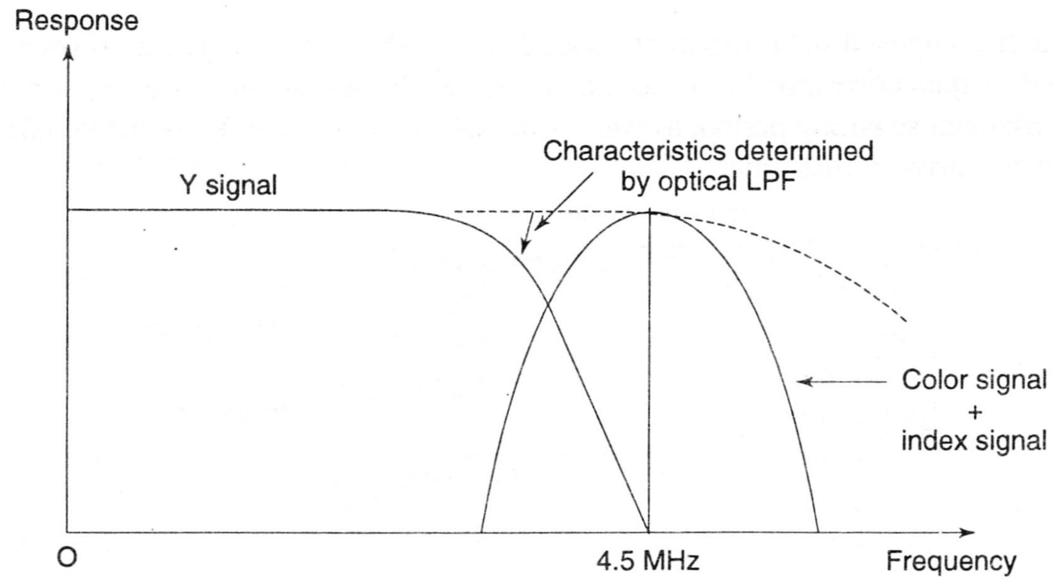
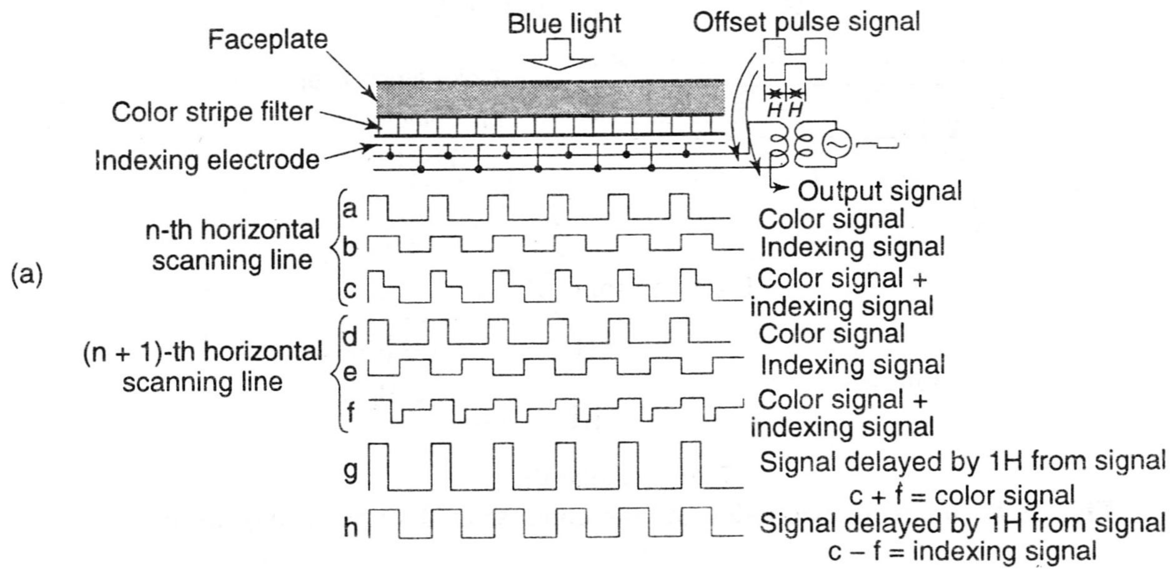


Fig. 22.8 Frequency response of the multiplexed signal (Sony Corp)



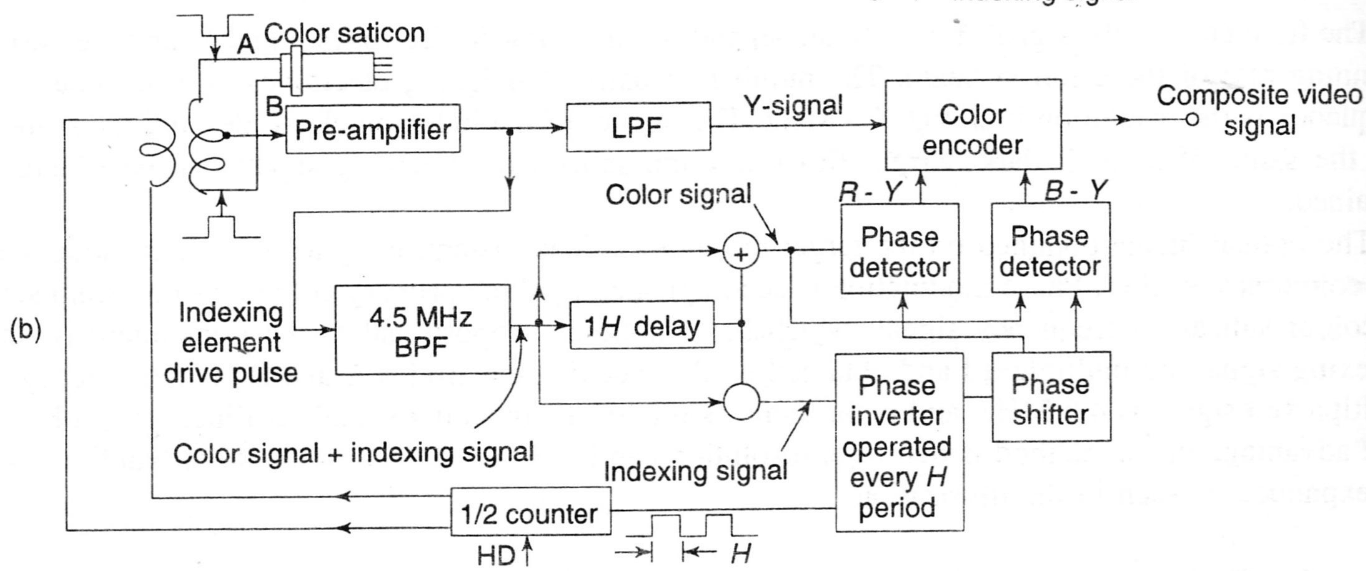


Fig. 22.9 (a) Dissection of the colour signal (b) Circuits to obtain composite video signal (Sony Corp)

and composite signal 'c' can be obtained. The indexing signal is reversed in polarity during the (n + 1)th horizontal scanning, and 'e' waveform can be obtained. The same colour signal waveform as in 'a', that is 'd', is generated and composite signal 'f' can be obtained. The actual signal contains the Y signal component, and RF signal components 'c' and 'f' are multiplied at the output. The signal thus obtained is then fed to further circuits shown in Fig. 22.9(b).

The Y signal component is obtained by LPF, and the 'colour signal + indexing signal' is obtained by the BPF centered at 4.5 MHz. Signal 'c' which is delayed by one H during the n-th horizontal scanning, and signal 'f', which is generated during the (n + 1)-th scanning, are added together to obtain colour signal 'g'. When 'f' is subtracted from 'c' indexing signal 'h' is obtained. The indexing signal is reversed in polarity every other horizontal line and the phase inverter circuit is used to arrange the indexing signal so that it is the same polarity every horizontal scanning. The phase inverter output must be, however, synchronised with the original indexing signal. In order to obtain the composite colour signal, the indexed signal, which has the same polarity every horizontal scanning, is fed through the phase shifter to the phase detector.

Video Camera Signal Processing

The small amplitude of pick-up tube signal is passed through a transformer, where the index signal is superposed onto the pickup tube output and fed into a low noise JFET input stage of a preamplifier via a series peaking coil. This reduces the effect of stray parallel capacitance and improves chroma frequency components and the S/N ratio in chroma band. Negative feedback is used to improve and adjust the LF response in the 1–2 MHz range.

The luma signal is processed for the following:

— AGC setting
— HF limiter
— horizontal detail generator for aperture correction
— vertical detail generator for aperture correction
— pedestal, Y-gamma correction and black clip
— negative/positive inversion, set up and white clip
— low light level attention
— automatic iris control
— chroma-gamma correction

The horizontal detail signal is obtained by subtracting the 150 ns delayed signal from the sum of the non-delayed and 300 delayed signals as shown in Fig. 22.10.

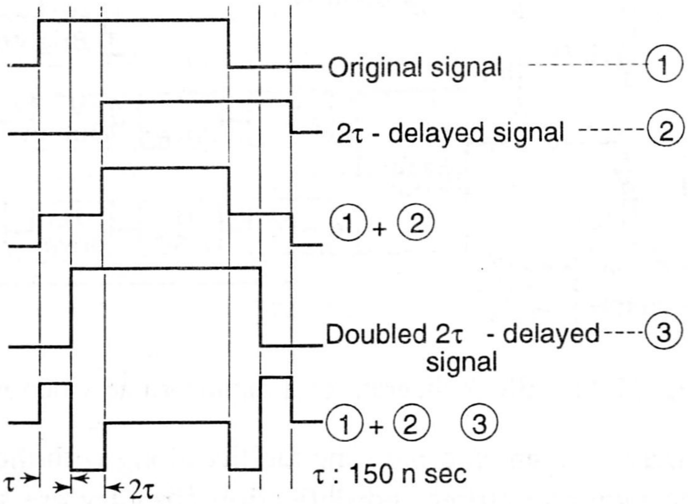


Fig. 22.10 Horizontal detail generator (Sony Corp.)

The 300 ns delayed signal is obtained by delaying the video signal twice with the help of a delay line reflected signal. This gives improvement in transient changes and aperture correction is effected.

The processing further provides for chroma signal processing and chroma encoding, shading correction for luma and chroma, automatic white balancing with the help of window gate generator, burst and sync mixing, fade in/out, colour bar generator and other facilities. Electret condenser microphone permits simultaneous audio recording.