Basics of Colour Television

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Formation of a Colour Signal

A colour camera produces red, green and blue video signals for each picture element.

A monochrome signal (Y) is formed by combining red (R), green (G) and blue (B) signals from their respective camera tubes in the following proportion:-

$$Y = 0.59G + 0.30R + 0.11B$$

Thus a colour Television transmitter should transmit R, G, B & Y signal informations, for which a colour sub-carrier frequency is introduced.

Different types of Colour TV Systems

There are three types of colour TV systems used in the world:-

- ***PAL System***
- ***SECAM***
- ***NTSC***

In India, PAL system is used.

PAL ➔ Phase Alteration Line

The PAL System

In PAL system, used in India, one part of the colour sub-carrier is directly modulated by R-Y video signal in an "In Phase Modulator". However, the phase of the colour sub-carrier is reversed on alternate lines by means of an electronic line-by-line switch.

The other part of the colour sub-carrier is passed through a 90^0 phase shifter and is then modulated by B-Y video signal in "Quadrature modulator".

The two AM signals combine together to produce the colour sub-carrier frequency of **4.43361876 MHz.**

Note:- A sub-carrier is a carrier that generates a modulated wave which is further employed to modulate another carrier.

CCIR TV Standard used in India

The TV signal to be received by the TV receiver has the following ranges:-

Band-width of audio signal(20 Hz to 20 KHz) = **1 MHz (FM)**

Band-width of video (picture) signal = *5 MHz* **(AM – VSB)**

Total Band-width of each TV channel = 7 MHz

The picture carrier IF is 5.5 MHz away from Sound carrier IF,
i.e., IF(p) – IF(s) = 5.5 MHz , where IF(s) = Sound IF = 33.4 MHz , and
IF(p) = Video IF = 38.9 MHz ;
Video is formed by taking 25 frames per second and each frame is scanned in 2 fields by interlaced scanning (each field being scanned by 312.5 lines). Thus, the vertical frequency of the camera (or, P. T.) beam is **2 x 25=50** *Hz while the horizontal frequency is* **2 x 25 x 312.5** *= 15625 Hz*

That is, the scanning frequencies are:-

Vertical frequency = 50 Hz & Horizontal frequency = 15625 Hz

Composite Video signal

The composite video signal is the combination of the video signal containing picture information (taken by camera) plus blanking pulses, to make the retrace invisible plus the Synchronizing pulses to synchronize the scanning of transmitter with the receiver

CVS = Pic info + Blanking pulses + Sync pulses

This CVS modulates the picture carrier – AM - VSB

Spectrum of the Colour Signal

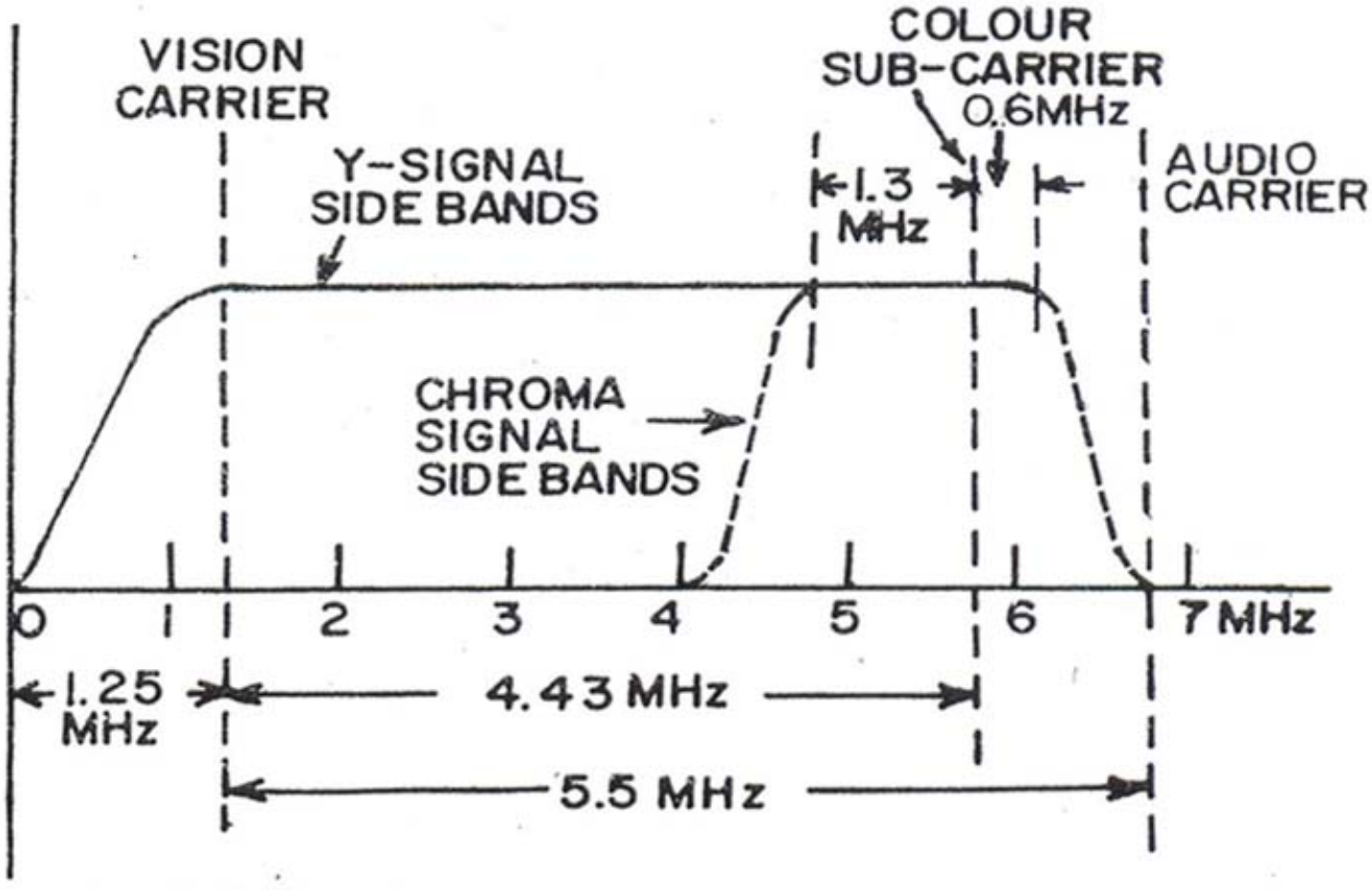


Fig. 2-8: The distribution of full colour signal within its allotted band.

Frequency Bands assigned for TV Transmission

Name of the TV Band	Freq-Range (MHz)	Channel Nos in the Band
Band-I (Lower VHF)	41 – 68	Ch-1 to Ch-4
Band-III (Upper VHF)	174 – 230	Ch-5 to Ch-20
Band-IV (UHF)	470 – 582	Ch-21 to Ch-36
Band-V (UHF)	606 - 870	Ch-37 to Ch-69

Picture Carrier frequency (f_p) = {(lowest ch-freq) + 1.25}

Sound Carrier frequency (f_s) = {(highest ch-freq) - 1.25}

Example:- for Ch-11(216 – 223) MHz, f_p = 217.25 MHz & f_s = 222.75 MHz

Frequencies of some channels (Band-I & III)

VHF : Band - I & III (41MHz-230MHz) Channels - 1 to 12

Range Of Band	Band	Channel No.	Frequency Range Or Band Width	Vision IF Carrier	Sound IF Carrier
Band - I	I	1	41MHz-47MHz	Not used for Television	
(41MHz-68MHz)	I	2	47MHz-54MHz	48.25MHz	53.75MHz
	I	3	54MHz-61MHz	55.25MHz	60.75MHz
	I	4	61MHz-68MHz	62.25MHz	67.75MHz
Band - III	III	5	174MHz-181MHz	175.25MHz	180.75MHz
(174MHz-230MHz)	III	6	181MHz-188MHz	182.25MHz	187.75MHz
	III	7	188MHz-195MHz	189.25MHz	194.75MHz
	III	8	195MHz-202MHz	196.25MHz	201.75MHz
	III	9	202MHz-209MHz	203.25MHz	208.75MHz
	III	10	209MHz-216MHz	210.25MHz	215.75MHz
	III	11	216MHz-223MHz	217.25MHz	222.75MHz
Additional Channel	III	12	223MHz-230MHz	224.25MHz	229.75MHz

Frequencies of some channels (Band-IV)

UHF : Band - IV (470MHz-582MHz) Channels - 21 to 36

Range Of Band	Band	Channel No.	Frequency Range Or Band Width	Vision IF Carrier	Sound IF Carrier
Band - IV	IV	21	470MHz-477MHz	471.25MHz	476.75MHz
470MHz-582MHz)	IV	22	477MHz-484MHz	478.25MHz	483.75MHz
	IV	23	484MHz-491MHz	485.25MHz	490.75MHz
	IV	24	491MHz-498MHz	492.25MHz	497.75MHz
	IV	25	498MHz-505MHz	499.25MHz	504.75MHz
	IV	26	505MHz-512MHz	506.25MHz	511.75MHz
	IV	27	512MHz-519MHz	513.25MHz	518.75MHz
	IV	28	519MHz-526MHz	520.25MHz	525.75MHz
	IV	29	526MHz-533MHz	527.25MHz	532.75MHz
	IV	30	533MHz-540MHz	534.25MHz	539.75MHz
	IV	31	540MHz-547MHz	541.25MHz	546.75MHz
	IV	32	547MHz-554MHz	548.25MHz	553.75MHz
	IV	33	554MHz-561MHz	555.25MHz	560.75MHz
	IV	34	561MHz-568MHz	562.25MHz	567.75MHz
	IV	35	568MHz-575MHz	569.25MHz	574.75MHz
	IV	36	575MHz-582MHz	576.25MHz	581.75MHz

Frequencies of some channels (Band-V)

Range Of Band	Band	Channel No.	Frequency Range	Vision IF Carrier	Sound IF Carrier
Band - V	V	58	774MHz-782MHz	775.25MHz	780.75MHz
(606MHz-870MHz)	V	59	782MHz-790MHz	783.25MHz	788.75MHz
	V	60	790MHz-798MHz	791.25MHz	796.75MHz
	V	61	798MHz-806MHz	799.25MHz	804.75MHz
	V	62	806MHz-814MHz	807.25MHz	812.75MHz
	V	63	814MHz-822MHz	815.25MHz	820.75MHz
	V	64	822MHz-830MHz	823.25MHz	828.75MHz
	V	65	830MHz-838MHz	831.25MHz	836.75MHz
	V	66	838MHz-846MHz	839.25MHz	844.75MHz
	V	67	846MHz-854MHz	847.25MHz	852.75MHz
	V	68	854MHz-862MHz	855.25MHz	860.75MHz
	V	69	862MHz-870MHz	863.25MHz	868.75MHz

Digital Satellite Television

The main advantage of using this technology is the much better picture and sound quality reception.

Early satellite television was broadcast in C-band: 3.7 GHz to 6.4-GHz frequency range.

Presently, Digital broadcast satellites are transmitting in the Ku band having frequency range (11.7 GHz to 14.5 GHz).

From Satellite to Home TV

Satellite programming originates in a studio and is carried to a large transmitting antenna, aimed at a precise spot in space, which is the location of the desired satellite.

The transmission is carried out at 5,900 to 6,300 MHz, known as Up-link frequency.

Satellite programming is relayed by means of a downlink transmitter on the satellite, back down to earth where it spreads to cover a vast area. This is carried on at about 3,700 to 4,200 MHZ, and it is known as downlink frequency

From Satellite to Home TV – cont'd

The signals from the satellite are received by a dish-antenna, amplified by LNB and sent to the Digital Satellite Receiver (Set-Top box) by co-axial cable.

The Digital Satellite Receiver (Set-Top box) selects the desired TV channel-signal, and process it by frequency conversion, amplification, and separating audio and video signals from it.

These audio and video signals are sent to the colour TV receiver by RCA-type A-V cables.

For high definition picture quality, LCD and plasma TV receivers are currently in use.

The colour TV trainer available in this laboratory, is an old model of CRT type, so it can not produce good quality picture.

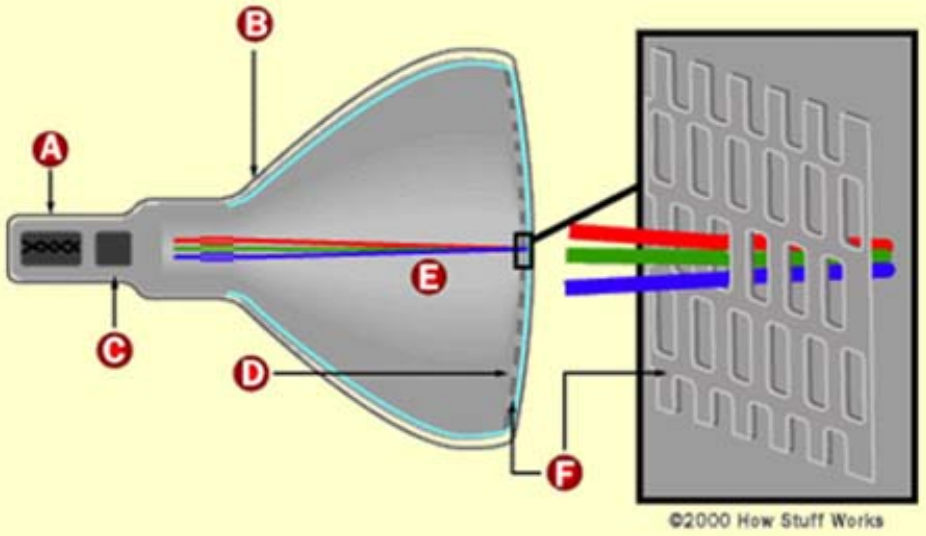
A Colour TV Screen

A colour TV screen differs from a black-and-white screen in three ways:-

- There are three electron beams that move simultaneously across the screen. They are named the red, green and blue beams.
- The screen is not coated with a single sheet of phosphor as in a black-and-white TV. Instead, the screen is coated with red, green and blue phosphors arranged in dots or stripes.
- On the inside of the tube, very close to the phosphor coating, there is a thin metal screen called a shadow mask.
- This mask is perforated with very small holes that are aligned with the phosphor dots (or stripes) on the screen.

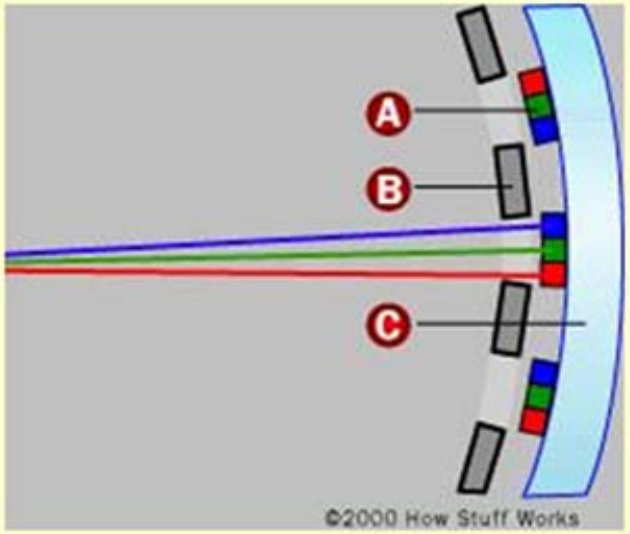
The next slide will show how the TV mask works.

Construction of Picture Tube



- **A** Cathode
- **B** Conductive coating
- **C** Anode
- **D** Phosphor-coated screen
- **E** Electron beams
- **F** Shadow mask

How the TV mask works



A Phosphors
B Shadow mask
C Glass

❖When a color TV needs to create a red dot, it fires the red beam at the red phosphor. Similarly for green and blue dotsTo create a black dot, all three beams are turned off as they scan past the dot. All other colors on a TV screen are combinations of red, green and blue.

❖To create a white dot, red, green and blue beams are fired simultaneously -- the three colours mix together to create white.

❖To create a black dot, all three beams are turned off as they scan past the dot. All other colors on a TV screen are combinations of red, green and blue.

Basic Arrangement of Colour TV Receiver

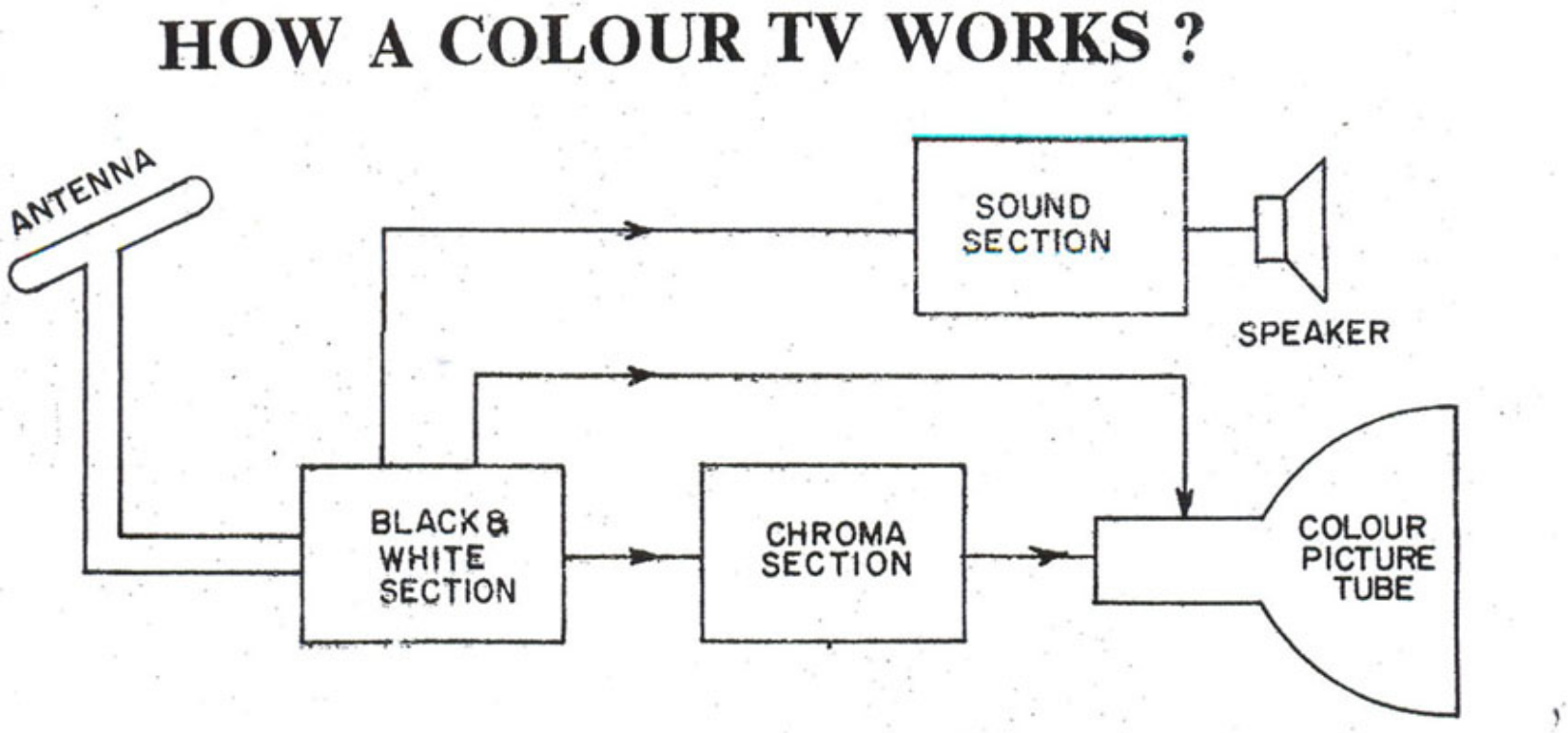
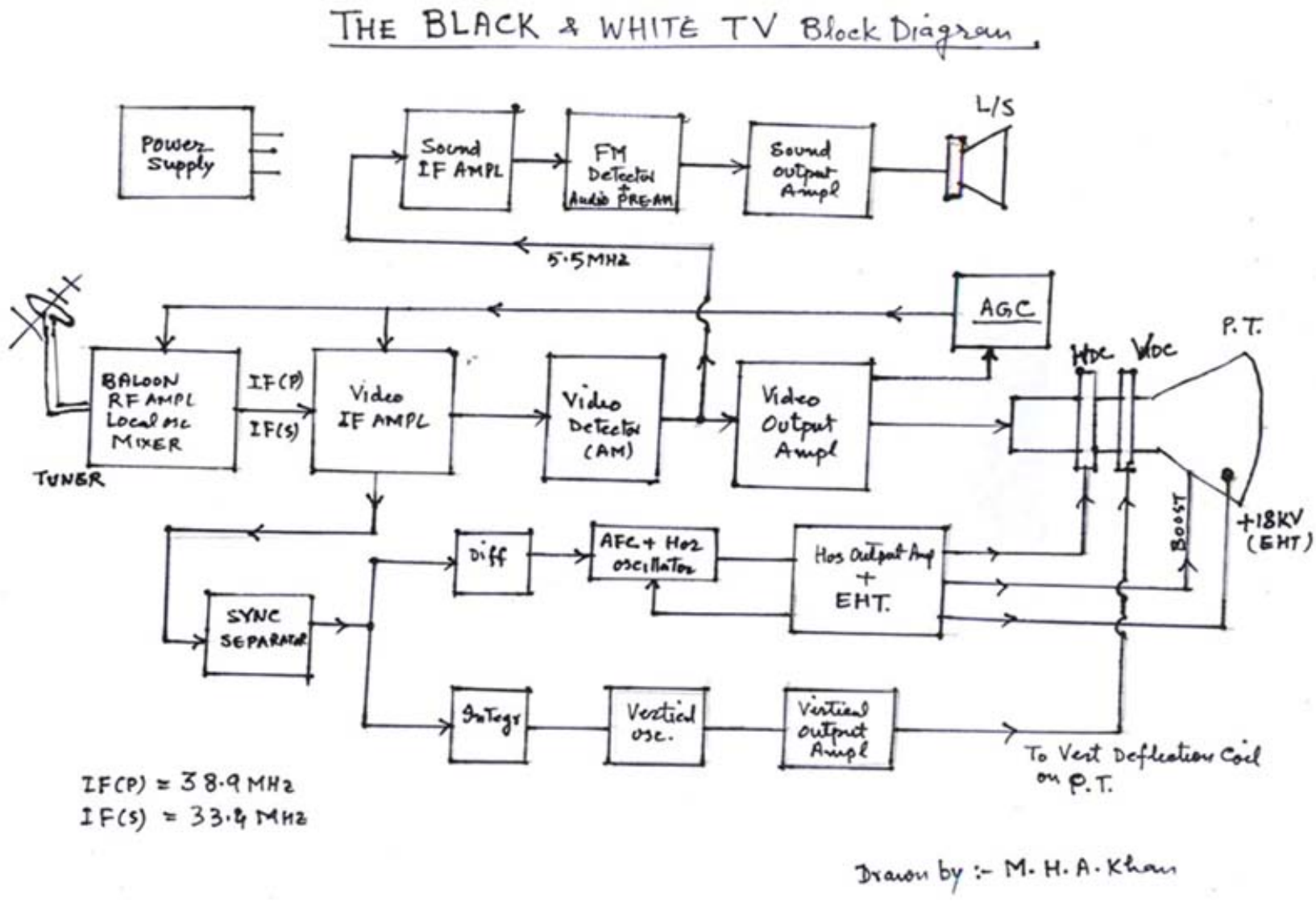


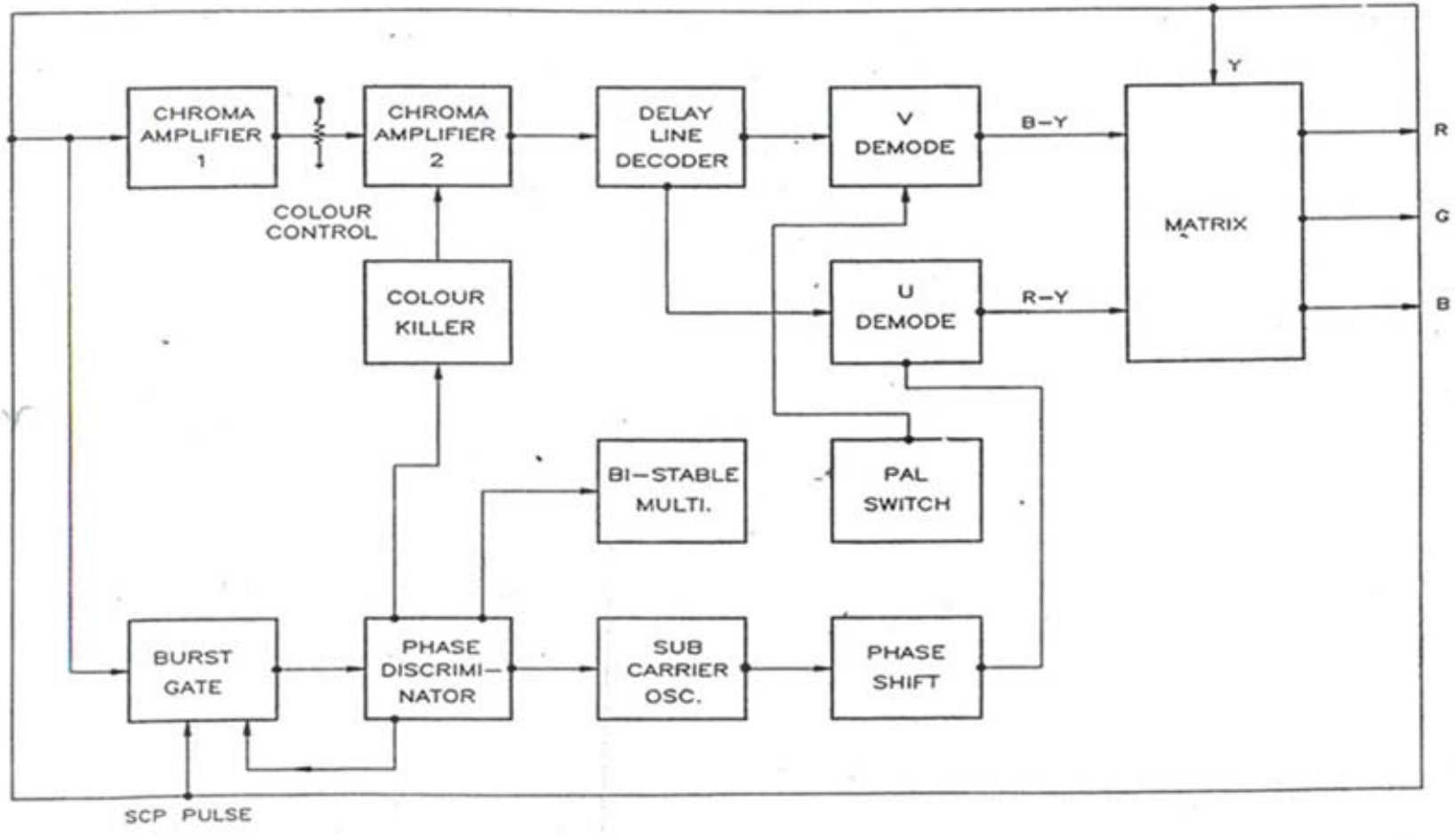
Fig. 5 1: Basic arrangement of a colour television receiver.

Basic Sections of a Black & White TV Receiver

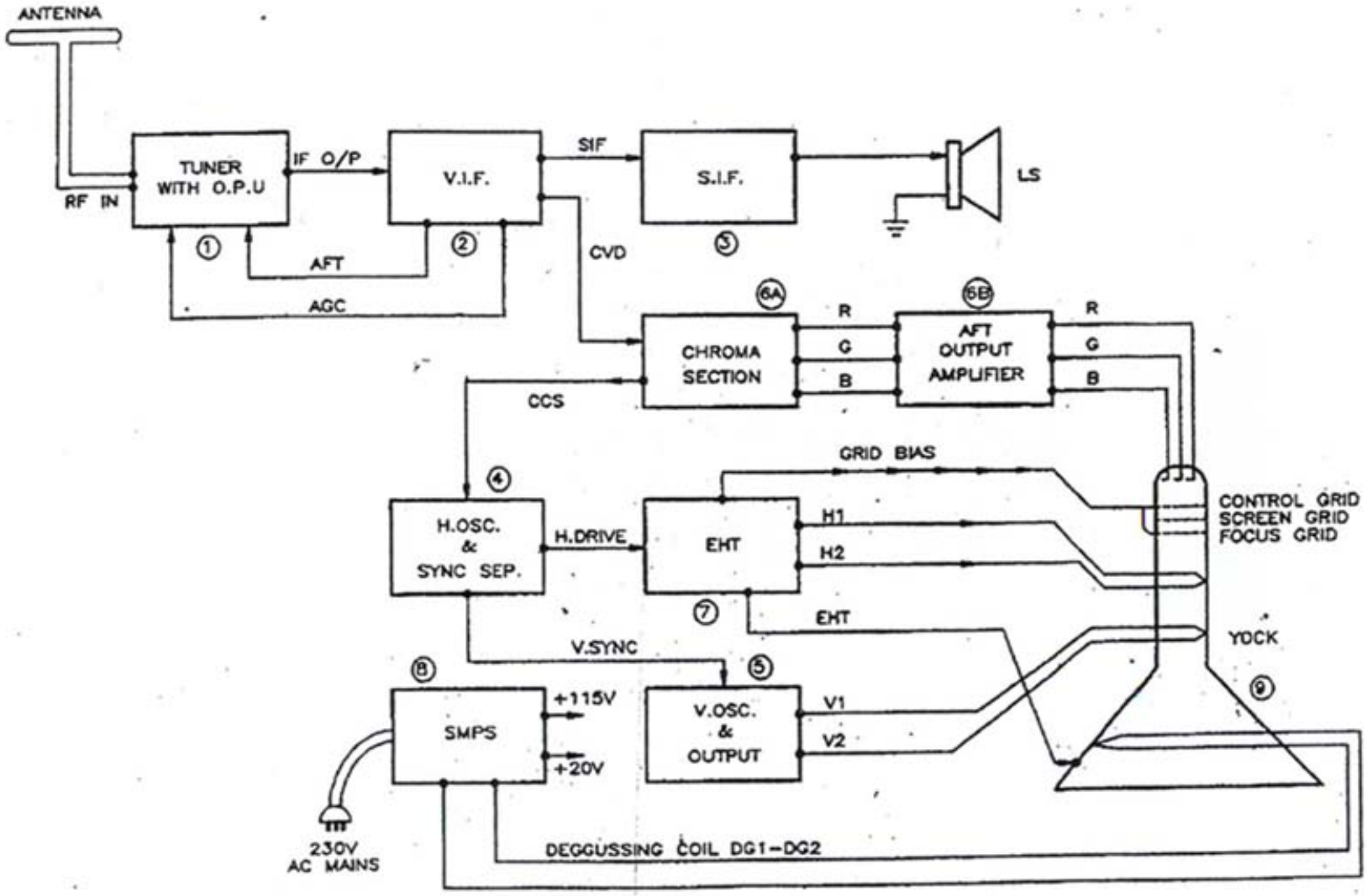


The Chroma Section of a Colour TV Receiver

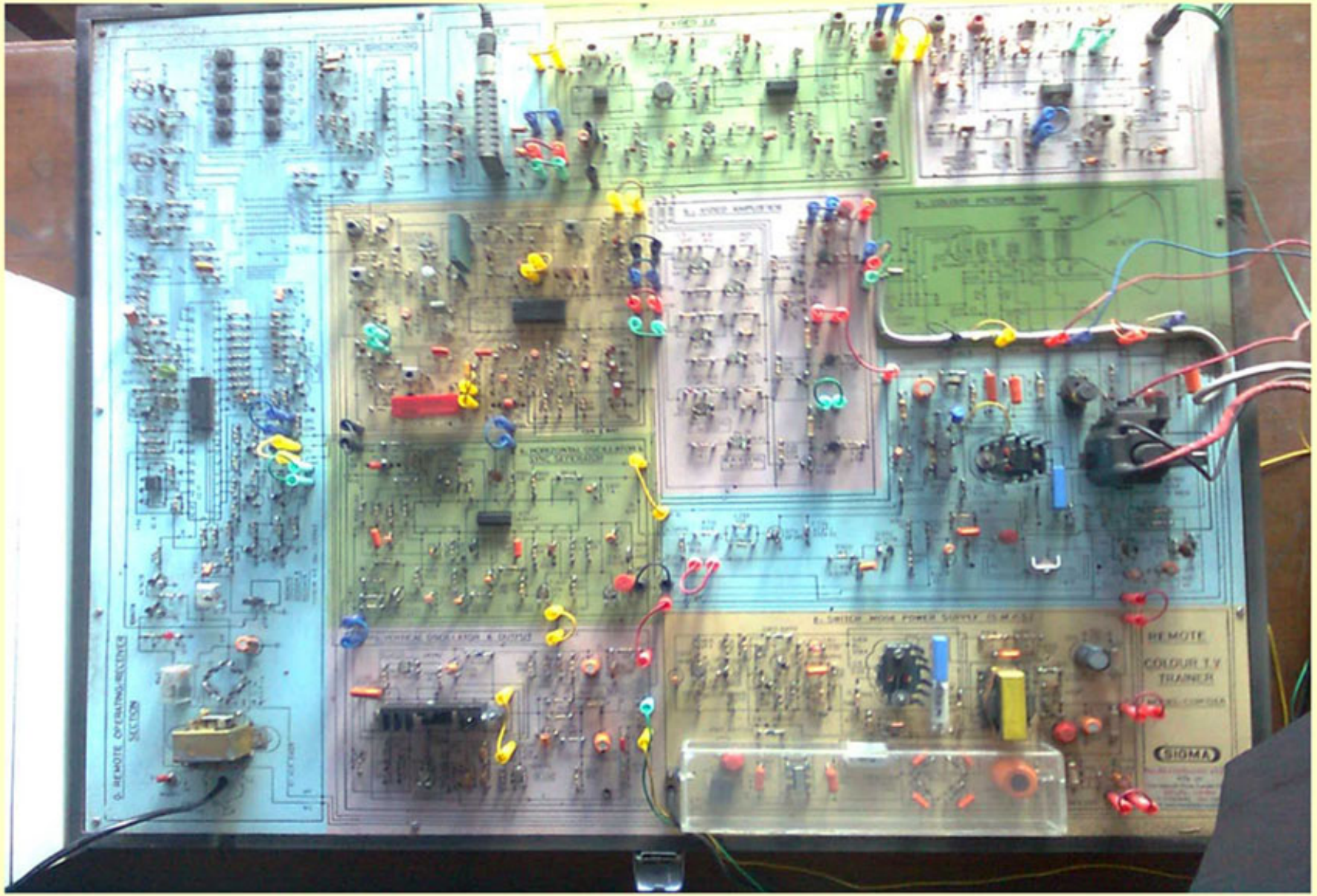
FFG: 2 BLOCK DIAGRAM OF CHROMA SECTION



Block Diagram of Colour TV Receiver



The Colour TV Trainer Kit



Sections of the Colour TV Trainer Kit

1. Tuner
2. Video I. F.
3. Sound I. F. and Audio Output Amplifier
4. Horizontal Amplifier & Sync Separator
5. Vertical Oscillator & Vertical output Amplifier
6. Video Output Amplifier
7. Colour Decoder
8. E. H. T.
9. S. M. P. S.
10. Colour Picture tube
11. Remote Operating Receiver section

Main Functions of different sections of Colour TV Trainer

The main function of a Colour T.V. receiver are as under: -

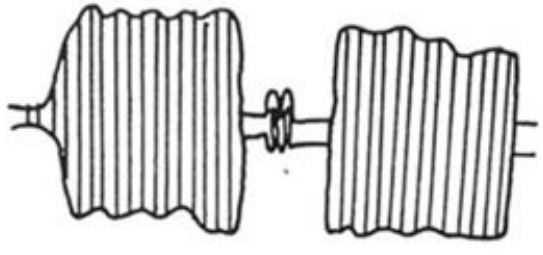
1. To select the signals of the channel and to amplify these and convert them into IF Signals.
2. To amplify the video and sound IF Signals, to demodulate the video IF Signals to obtain the composite Video Signal, to mix the two IF signals to obtain the inter- carrier sound IF Signal and to preamplifier these.
3. To separate the combined luminance (Y) and chroma signals from the video IF Signals and to amplify these.
4. To separate the luminance (Y) and chroma i.e. U & V (R-Y and B-Y) Signals from the combined video Signal.
5. To regenerate sub-carrier signal with phase locking with the sub-carrier burst.
6. To decode the chroma signal to obtain the modulated U and V signals and to demodulate them with the Help of regenerated reference carrier.
7. To combine the Y, U and V signals (Matrixing) to obtain the colour i.e. R, G and B signals.
8. To amplify them and to give them to the respective cathodes of the colour picture which reproduces these As colour picture with the help of horizontal and vertical sweeps.
9. To produce horizontal and vertical sweeps synchronized with the respective sync signals and to give them to the respective deflection coil for producing the sweep.
10. To separate the sound IF signal, to amplify, limit and demodulate them, and to give them to the Loudspeaker at sufficient amplitude.
11. To provide power at suitable D.C. voltages for operating various stages, providing supply to various Electrodes of picture tube and for heating its cathode.
12. To provide infrared remote control operations.

Waveforms of Some Signals of the Colour TV

Y SIGNAL- IC TDA 3561A - PIN 10

0.4V PP (H)

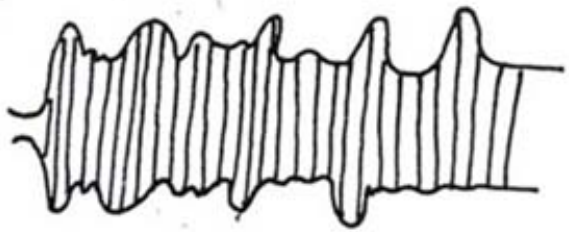
CHROMA SIGNAL - IC TDA 3561A - PIN 3



150 MV-PP (H)

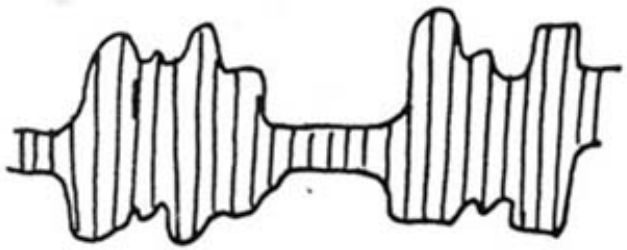
Waveforms of Some Signals of the Colour TV

33 R-Y SIGNAL - IC TDA 3561A - PIN 22



200 MV P-P (H)

B-Y SIGNAL - IC TDA 3561A - PIN 21



150 MV PP (H)

Some Common faults of the Colour TV

Nature of the fault	Cause / faulty-section
No Raster, No Picture, No sound	SMPS section faulty
Only Hor-line appears on the screen, Sound is normal	Faulty Vertical Section
Picture is rolling diagonally	Failure of sync pulses
No Colour, B/W picture OK, sound OK	Colour Decoder faulty, Adjust preset C875

References:

1. *Gulati : Monochrome and Colour Television*
2. *Grob : Colour Television Engineering*
3. *Colour TV Trainer Manual*
4. *Whitaker : Digital TV Fundamentals*
5. *Alencar : Digital TV Systems*

Thank You !

Produced & Presented by:-

Engr M. Hadi Ali Khan

Website

http://mhakhan.tripod.com