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AN ECONOMICAL COLOUR GRAPHICS MONITOR

by

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1. INTRODUCTION

There is a growing requirement for colour graphics monitors interfaced to computers. This memorandum describes a low cost colour monitor based on a domestic television receiver and the necessary modifications required to drive it from Red, Green, Blue video signals with separate synchronisation signals.

In recent years the performance, reliability and quality of domestic colour television receivers has improved. Much more attention has been paid to quality of construction and the use of "professional" type components. This has resulted in a low cost reliable electronic instrument being available to adapt and meet the needs of computer graphics.

2. DESIGN CONSIDERATIONS

2.1 Colour Monitor Input Signals

There are three basic ways of producing drive signals to a colour monitor.

1. Composite video P.A.L. coded and superimposed onto an r.f. carrier.
2. Composite video P.A.L. coded and matched to a 75 Ω coaxial line.
3. Direct Red, Green, Blue video drives with separate synchronising signals matched to a 75 Ω line.

The first two systems would require P.A.L. encoded signals to be generated which is a relatively complex process also requiring wide band r.f. circuitry in the first case. Both these systems would also rely on the monitor decoding the P.A.L. signals which is undesirable as it reduces the bandwidth of the final display signal.

Supplying the R.G.B. and synch signals is the most direct method of driving the display giving the best quality picture and proving the most cost effective way of modifying a colour receiver. Encoding at the computer driver and decoding at the monitor is not required. Linear wideband amplifiers are required between the driver and the display tube. With this system maximum resolution can be achieved giving better performance than the alternatives.

As this type of drive is not dependent upon a specific colour transmission standard e.g. P.A.L. N.T.S.C. SECAM two way exchange of data may be exchanged far easier with other countries.

2.2 Choice of Monitor Mainframe

A 14" monitor was chosen since it offers good viewing charateristics for use in a laboratory environment. The latest domestic TV receivers offer advanced circuit design together with low power consumption latest technology tube design and are expected to give very good reliability.

The standard resolution stripe phosphor screen with inline electron gun has approximately 500 vertical lines which is made up of 1500 vertical phosphor stripes. It is necessary to make the pixel cover two vertical lines to ensure good resolution allowing for scanning and focus errors: stripe pitch is 0.6 mm.

The display is self converging with a good contrast level 64 characters (one character = 9 × 6 pixels including spaces) per line with 24 lines per frame is possible. This allows a sampling error of up to ±1 triad per pixel.

3. PROTOTYPE

A Thorn TX9 chassis was modified by removing the UHF tuner, Intermediate Frequency Amplifier Module and also the sound and video processing IC's. This was carried out to save current consumption to allow the additional components to use the existing receiver power supply (fig.1).

A buffer amplifier board was designed for the red, green and blue input signals to drive the output stages which in turn drive the tube. A buffer amplifier was also provided for the synchronisation circuits.

The existing beam current limiter circuit was reconfigured to make it compatible with the new interface circuit. A "C" core mains transformer was fitted to give low external magnetic flux radiation preventing CRT scanning or colour purity errors and giving safety isolation. The monitor was fitted to a 19" (49 cm) rack mounting cabinet (fig.2).

4. PRINCIPLE OF OPERATION

The operation of the monitor is as for the TX9[1] with the exception of the following modifications.

Four signals are received at the monitor they consist of three video signals with amplitudes of 1 volt peak to peak positive going. The fourth signal is a synchronisation signal of 2 V peak to peak negative going.

The buffer amplifier increases the video signal to a level of 3.5 V peak to peak to drive the Class A video output transistors which drive the cathodes of the tube.

Variable attenuation of each of these buffer video amplifiers provide contrast control and further components are used for adjustment of brightness.

Design changes have been made to the original beam limiter circuit so that the new contrast and brightness control circuits may track with the limiter ensuring that the total beam current of the tube does not exceed 600 µA.

A block diagram schematic fig.3 shows the arrangement of the complete monitor.

5. CIRCUIT DESCRIPTION

5.1 Red Green Blue Buffer Amplifiers

It is conventional practice to distribute video signals via coaxial cable having a characteristic impedance of 75 Ω carrying signal amplitudes of 1 V peak to peak.

Six B.N.C. sockets provide connections to the monitor. Loop through facilities are provided for forward linking these signals to other monitors. Change-over switches select this option and simultaneously remove local line termination as shown in fig.4.

All three video amplifiers are identical in design having a bandwidth of over 70 MHz (fig.5).

Video signals are a.c. coupled via C1 to the base of TR1 the amplifier has a gain of 3. C4 and C5 a.c. couple through the base of TR3 emitter follower.

The contrast of the picture is proportional to the signal gain, by reducing the amplitude the contrast will decrease. TR4 is a J FET device operating as a variable attenuator controlled by the contrast potentiometer. The contrast potentiometer provides a common control for TR8 and TR12. Picture brightness is controlled by altering the base voltage of the emitter follower TR3.

5.2 Frame, Line Blanking and Synchronisation Circuits

Figures 6(a) and 6(b) show the frame and line blanking circuits.

TR15 amplifies frame and line blanking pulses which are fed to TR3 via D1 turning the video amplifiers off on flyback, fig.6(a).

External synchronising pulses have termination and loop through facilities available on BNC sockets similar to the video inputs. The synch signals have an amplitude of 2 V peak to peak negative going. Positive going signals are required to drive the already existing synch circuits. The input signal is inverted by TR13 and buffered by emitter follower TR14, fig.6(b).

5.3 Beam Current Limiting

The 14" tube used in the monitor has a beam current limit set to 600 µA to protect the tube from excessive heating of the shadowmask (which would cause purity errors) and also gives good control of EHT.

The beam current limiter prevents the tube exceeding this value, controls the maximum power dissipation of the receiver and controls picture size. When any of these errors are detected by the limiter circuit both brightness and contrast are reduced proportionally by applying a control voltage to the video processing IC.

As the modified receiver does not use the video processing IC, the beam limiter was adapated for use with the new interface board and controls the gain of the RGB buffer amplifiers by off-setting the gate potential on the variable FET attenuators (fig.7).

6. TEST PROCEDURES

6.1 Preset Adjustments

The monitor was set up using the Philips PM5519 colourbar and pattern generator in conjunction with a Link Electronics P.A.L. decoder 228/567.

The picture was underscanned both vertically and horizontally to enable data at the very edge of the scan to be identified. Greyscale tracking and linearlity adjustments were made in accordance with the manufacturers' instructions. Particular emphasis was made of the setting of the supply line voltage as any inaccuracy would be reflected in the tube heater supply (derived from the line output stage) subsequently reducing the life of the instrument.

6.2 Safety Consideration and Checks

Cathode ray tubes operated with a final anode volts of more than 25 kV can under certain circumstances emit forward x-ray radiation. Although the manufacturers of the television design well below these parameters with a final anode of 24 kV the radiation level was monitored since the receiver had been modified.

An EMI RM2 ratemeter was used to measure forward x-ray radiation at the screen face and core, measurements were well within the international safety limit of 0.5 MR/h at maximum beam current.

Final anode volts were monitored simultaneously using a Bradenburg 88M EHT meter and did not exceed 24 kV.

The metal cabinet of the monitor was assembled in sections and bolted together, a separate earth bonding cable was attached to each panel and returned to a common earth to provide extra safety.

The power supply uses a bridge rectifier connected across the mains input which makes the chassis live irrespective of mains polarity. An isolating transformer was introduced into the mains supply to ensure safety and allow mains earthing to the cabinet.

7. HIGH RESOLUTION DISPLAY

The monitor has been further developed for use with the new range of high resolution CRT display which enables a better quality picture using a super fine matrix with phosphor dot pitch of 0.3mm. This will display 24 lines of 870 characters at a total of 2000 characters. These figures are for good resolution including redundancy, more characters could be displayed but with deterioration in quality (fig.8).

The luminance output is lower from a high resolution tube because of the fine pitch shadowmask, beam current is also reduced.

Circuit modifications were necessary to limit the beam current to 450 μA and the value of two components were changed to compensate for a difference of line scan coil inductance associated with the new tube.

8. CONCLUSION

The modification of domestic TV sets has proved a cost effective method of providing low cost colour graphics monitors, Fig.9 shows a modified unit. Many of these monitors have been installed giving good performance and high reliability.

It has also been demonstrated that the provision of a high definition colour tube to the monitor is a practical solution to the provision of low cost high definition monitors.

ACKNOWLEDGEMENTS

My thanks to the members of Thorn EMI design and development team at the Bradford Engineering Centre for the information and assistance they have given to me in undertaking this project and their permission to reprint part of the service information for the TX9.

Particular thanks to Mr. K.P. Cope for assistance and helpful discussions in the design of wideband circuits and to Dr. M.M. Przybyulski for his assistance in preparing this document.

Finally my appreciation to Mr. G. Hughes for his encouragement and support throughout the project.

REFERENCE

1. TX9 Colour television service manual available from Thorn Consumer Electronics Ltd., Service Division, P.O. Box 121, Lea Valley Trading Estate, Edmonton, London N18 3BP.

APPENDIX

MONITOR SPECIFICATION

EC581

Employs 14" tube incorporated in lightweight plastic case.

EC582

Employs 14" tube incorporated in aluminium case designed for 19" (49 cm) rack mounting.

DISPLAY

90° rectangular glass picture tube. Featuring a perfectly rectangular screen of 3 × 4 aspect ratio. Inherent self converging system with integral saddle toroidal yoke. In line gun slotted shadowmask which is temperature compensated. Hybrid type black stripe screen giving high level of brightness and contrast. EHT 24 kV at zero beam current Quick start cathode.

IMPLOSION PROTECTION

Integral.

X-RADIATION

Less then 0.5 mR/H.

SCANNING SYSTEM

CCIR 625 line.

DEGAUSE

Automatic on switch. on.

INPUTS

All bnc sockets 75 Ω with loop through

INPUT LEVELS

Red, Green and Blue inputs each require a video signal of 1 V peak to peak (positive going video). Sync input requires 2 V peak to peak negative going syncs.

BANDWIDTH

6 MHz.

POWER SUPPLY

Normal 240 V 50 Hz. The monitor will operate satisfactorily on a.c. mains supplies between 185 V and 256 V. No mains input adjustment required.

POWER CONSUMPTION

Typically 60 W for normal picture, 45 W at zero beam current and 65 W maximum.

TEMPERATURE RANGE

UP TO 60°C MAX INSIDE CLOSED CABINET

MAX EXTERNAL AMBIENT 45°C.

FIGURE CAPTIONS

Fig.1	TX9 printed circuit board showing where components no longer required have been removed.
Fig.2	14" colour monitor fitted in 19" rack mounting cabinet.
Fig.3	Complete monitor block diagram.
Fig.4	Termination of video signal.
Fig.5	Red channel video amplifier circuit.
Fig.6(a)	Blanking amplifier circuit.
Fig.6(b)	Sync inverter and amplifier circuit
Fig.6(c)	Interface printed board.
Fig.7	Beam limiter circuit.
Fig.8	High resolution colour tube dot structure.
Fig.9	Complete monitor.

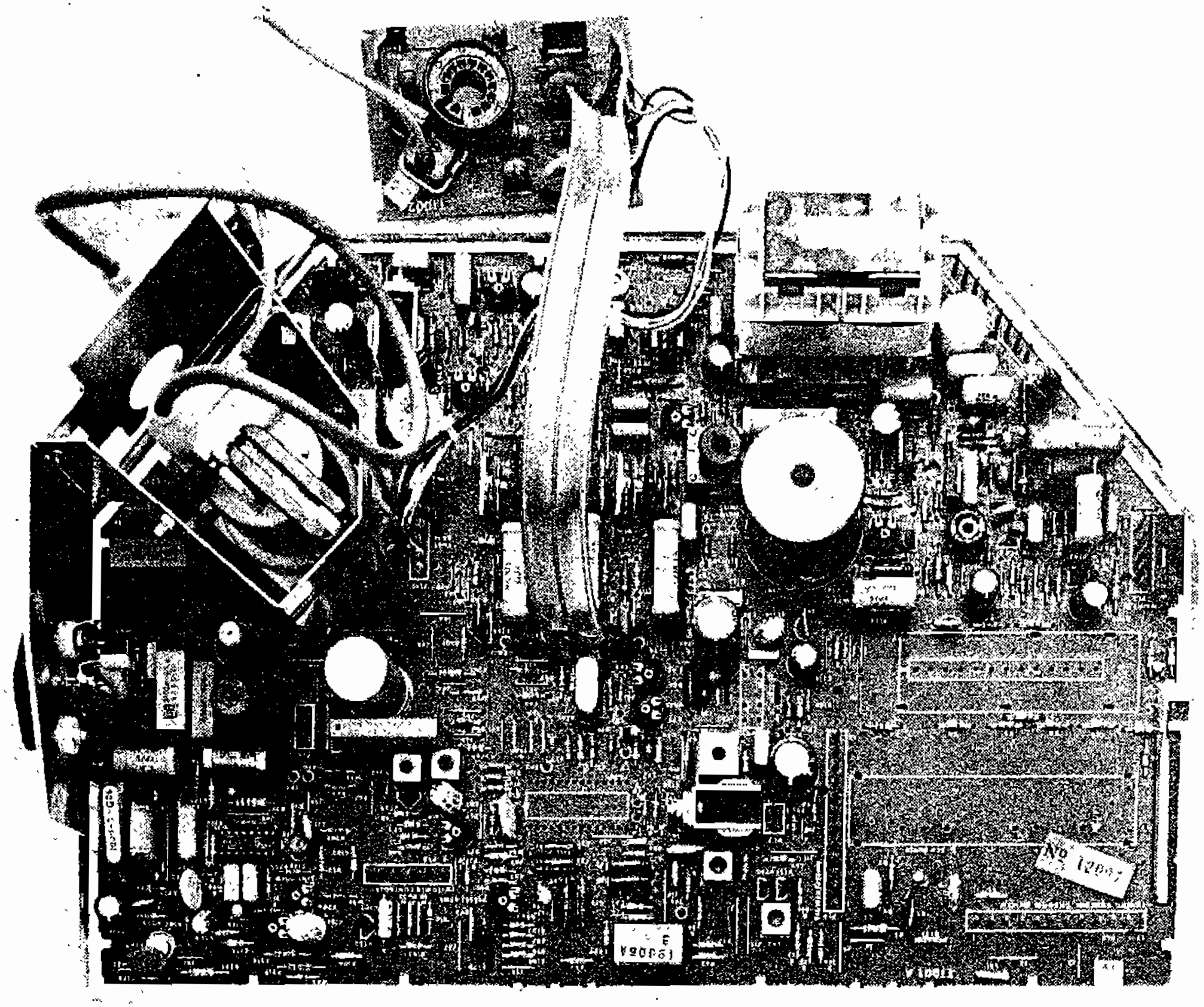


Fig.1

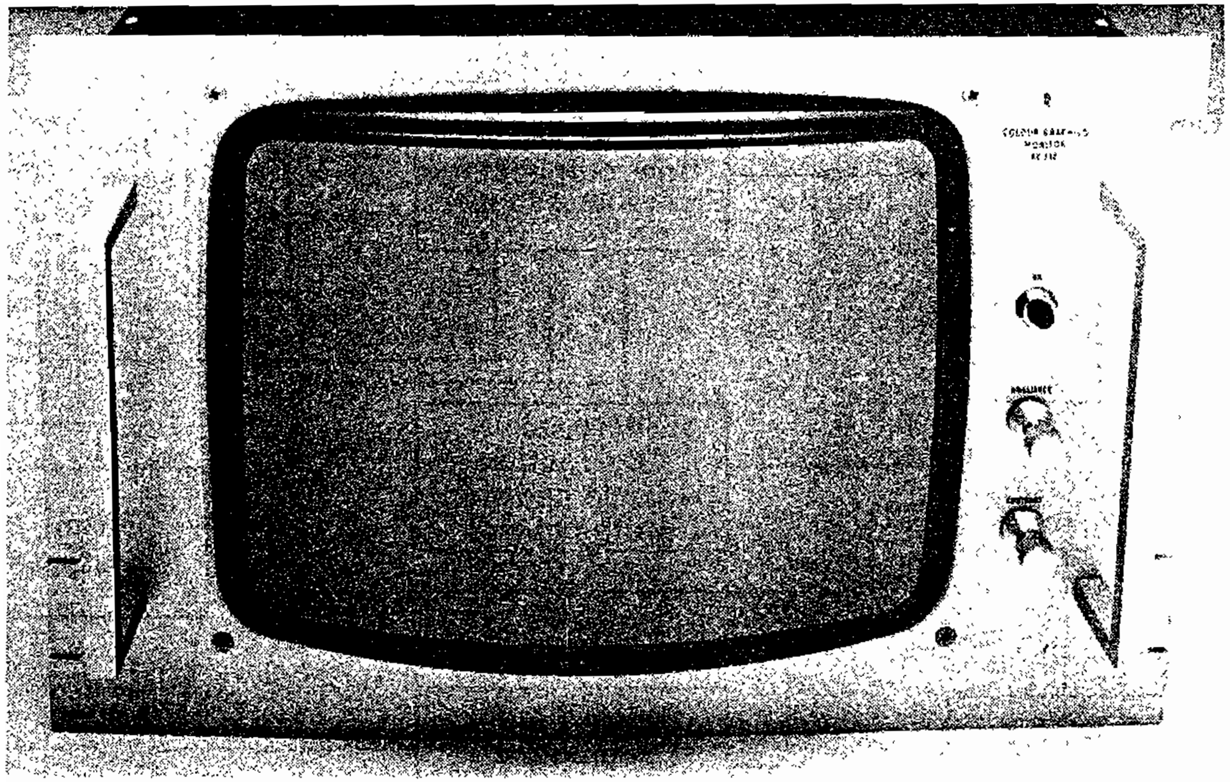


Fig.2

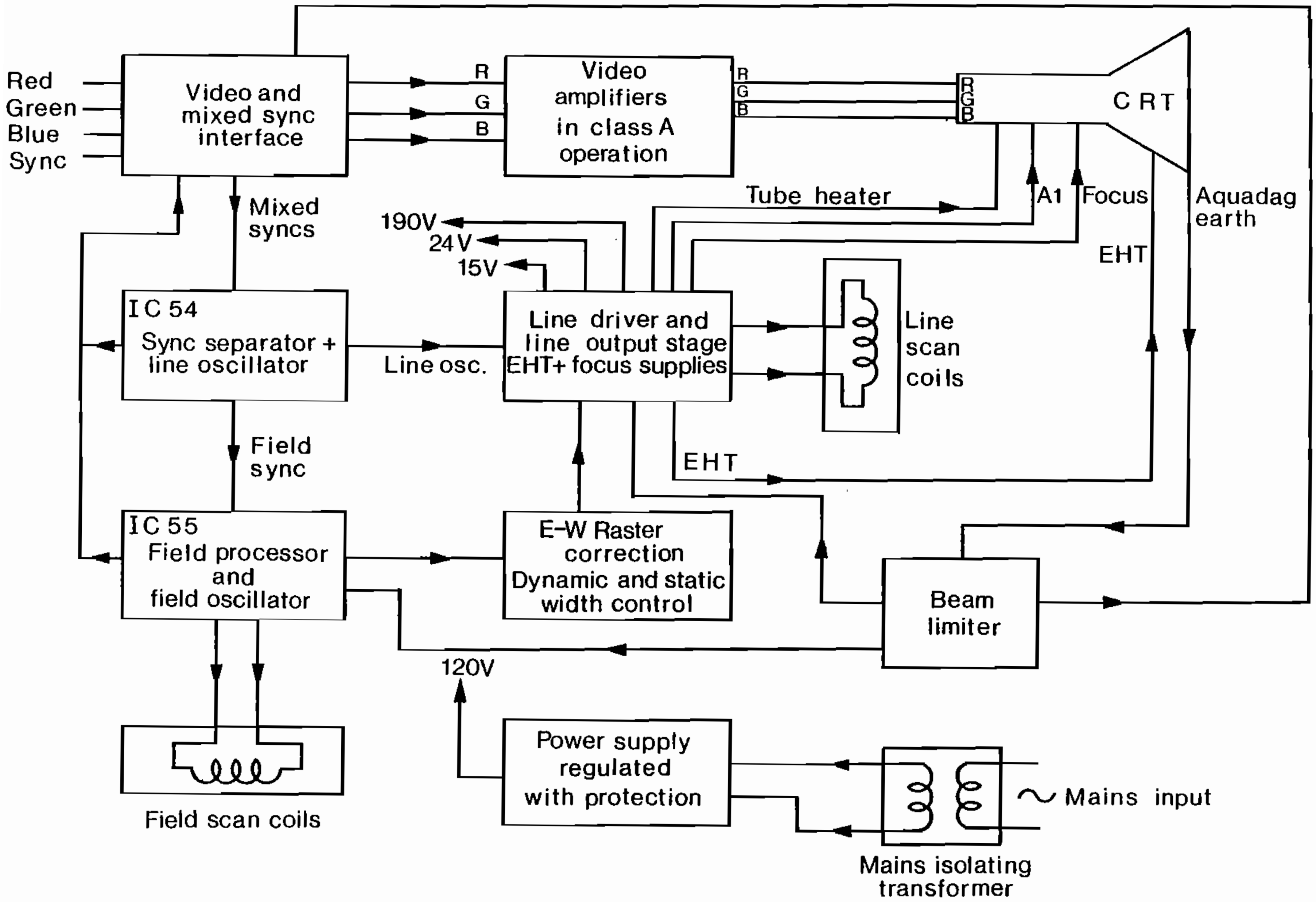

Red
Green
Blue
Sync
Video and mixed sync interface
R
G
B
Video amplifiers in class A operation
R
G
B
C R T
Mixed syncs
Tube heater
A1
Focus
Aquadag earth
190V
24V
15V
EHT
IC 54
Sync separator + line oscillator
Line osc.
Line driver and line output stage EHT+ focus supplies
Line scan coils
Field sync
EHT
IC 55
Field processor and field oscillator
E-W Raster correction Dynamic and static width control
Beam limiter
120V
Field scan coils
Power supply regulated with protection
Mains input
Mains isolating transformer

Fig. 3

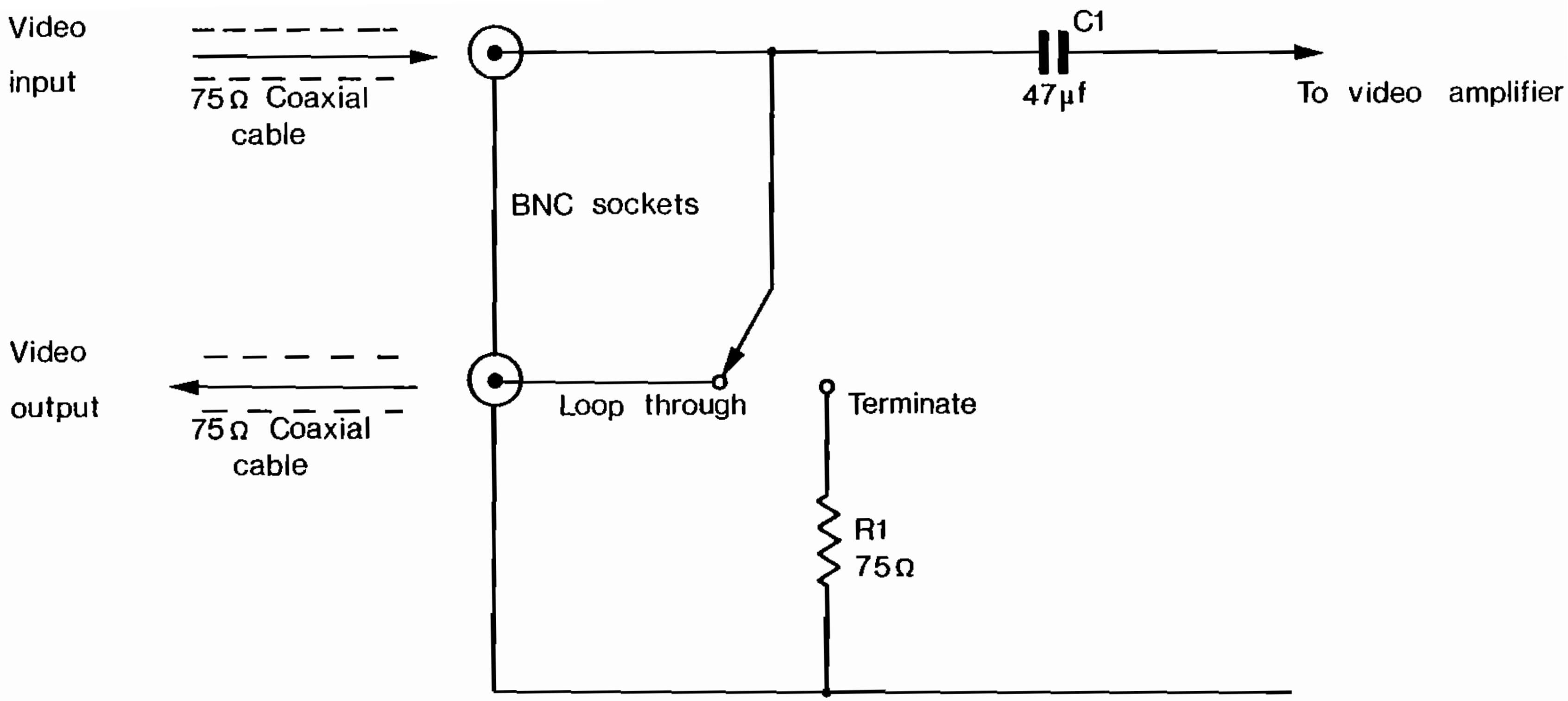

Video
input
75Ω Coaxial
cable
C1
47μf
To video amplifier
BNC sockets
Video
output
75Ω Coaxial
cable
Loop through
Terminate
R1
75Ω

Fig. 4

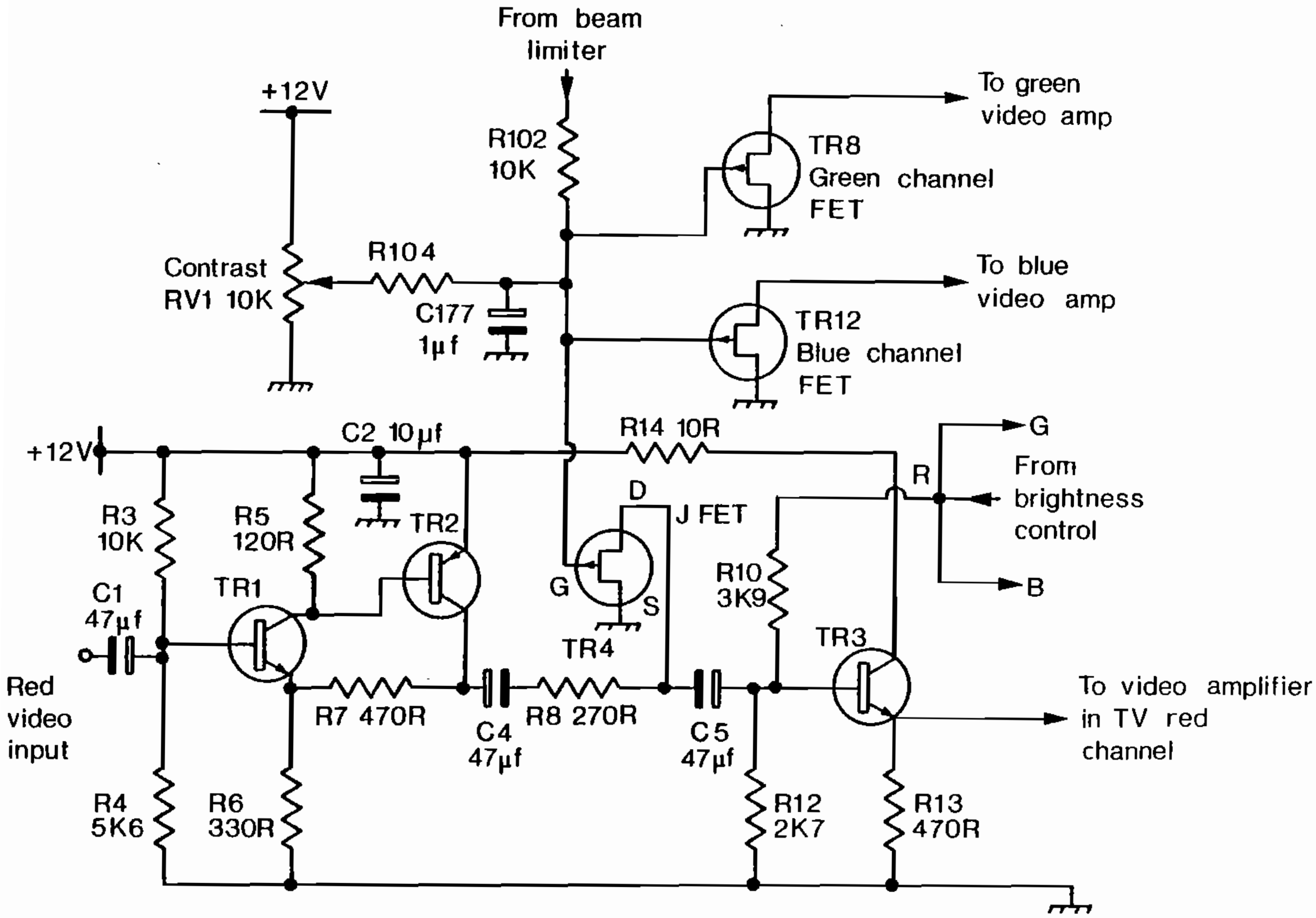

From beam limiter
+12V
R102 10K
To green video amp
TR8 Green channel FET
Contrast RV1 10K
R104
C177 1µf
To blue video amp
TR12 Blue channel FET
+12V
C2 10µf
R14 10R
G
R
From brightness control
B
D
J FET
R3 10K
R5 120R
TR2
G
S
TR4
R10 3K9
C1 47µf
TR1
TR3
Red video input
R7 470R
C4 47µf
R8 270R
C5 47µf
To video amplifier in TV red channel
R4 5K6
R6 330R
R12 2K7
R13 470R

Fig. 5

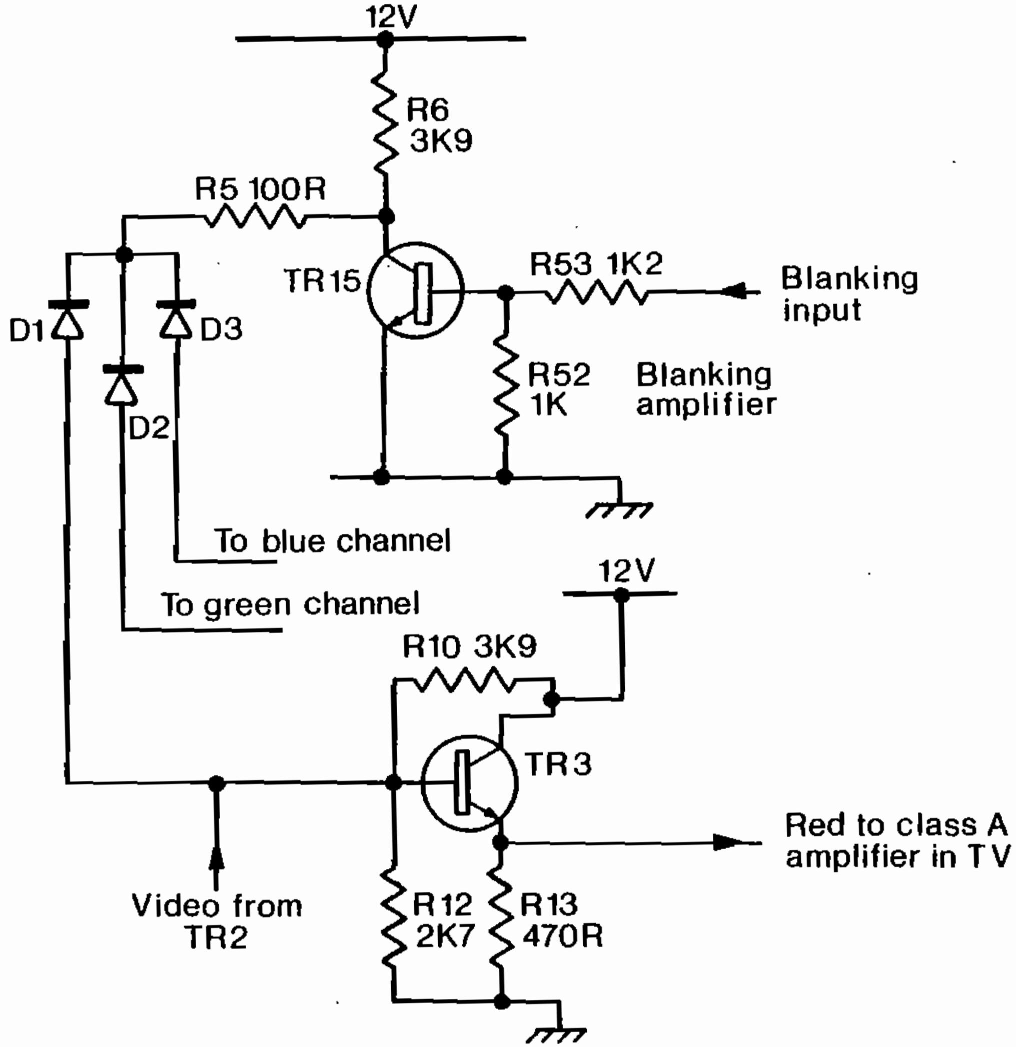

12V
R6
3K9
R5 100R
TR15
R53 1K2
Blanking
input
D1
D3
D2
R52
1K
Blanking
amplifier
To blue channel
12V
To green channel
R10 3K9
TR3
Red to class A
amplifier in TV
Video from
TR2
R12
2K7
R13
470R

Fig. 6(a)

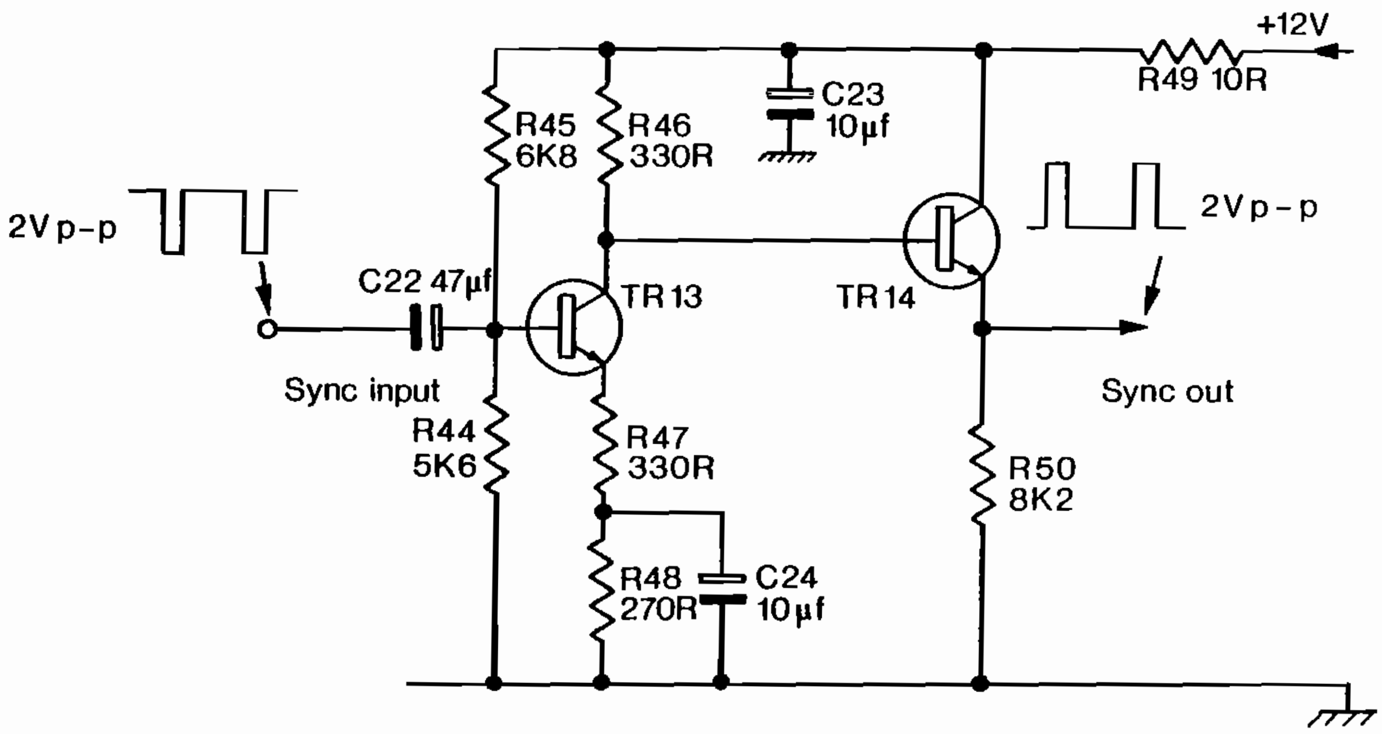
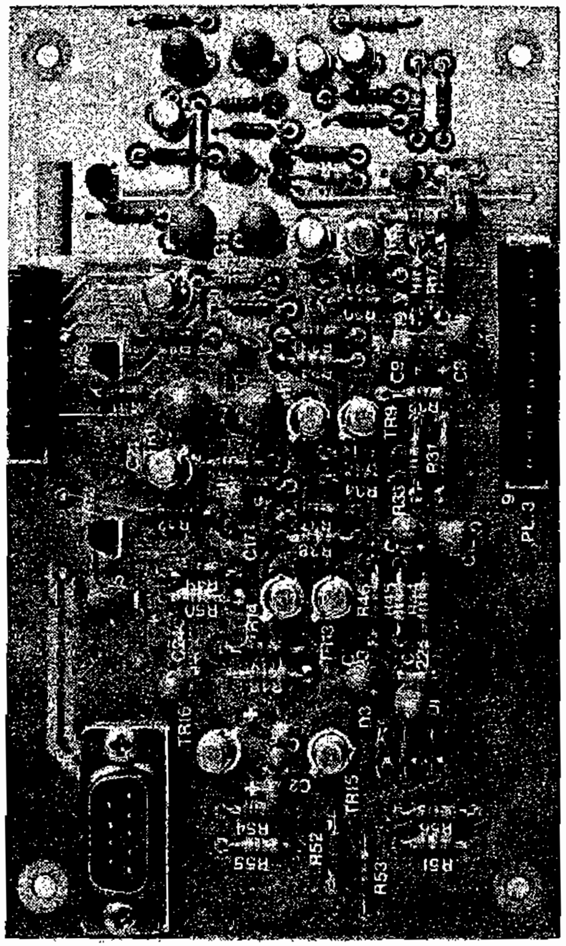

+12V
R49 10R
R45
6K8
R46
330R
C23
10µf
2Vp-p
2Vp-p
C22 47µf
TR13
TR14
Sync input
Sync out
R44
5K6
R47
330R
R50
8K2
R48
270R
C24
10µf

Fig. 6(b)



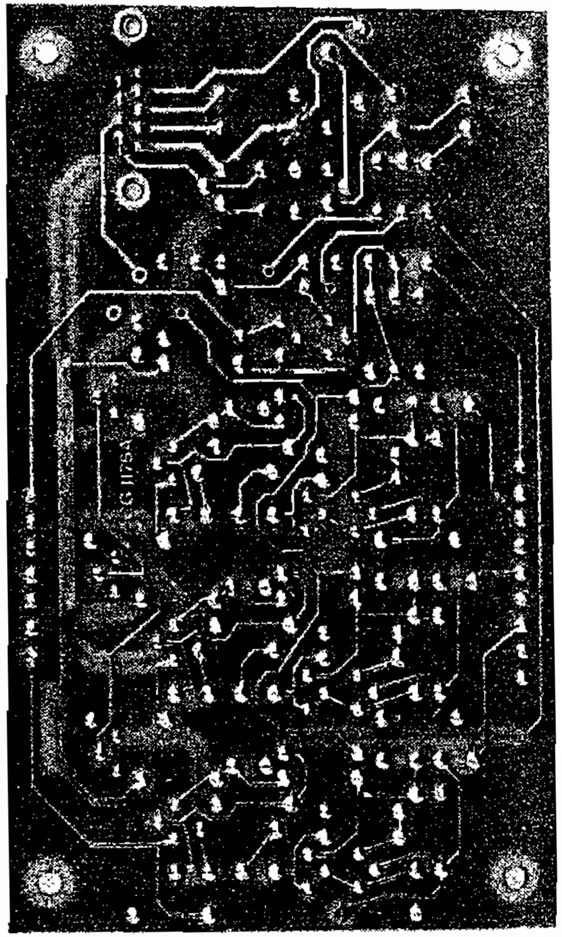
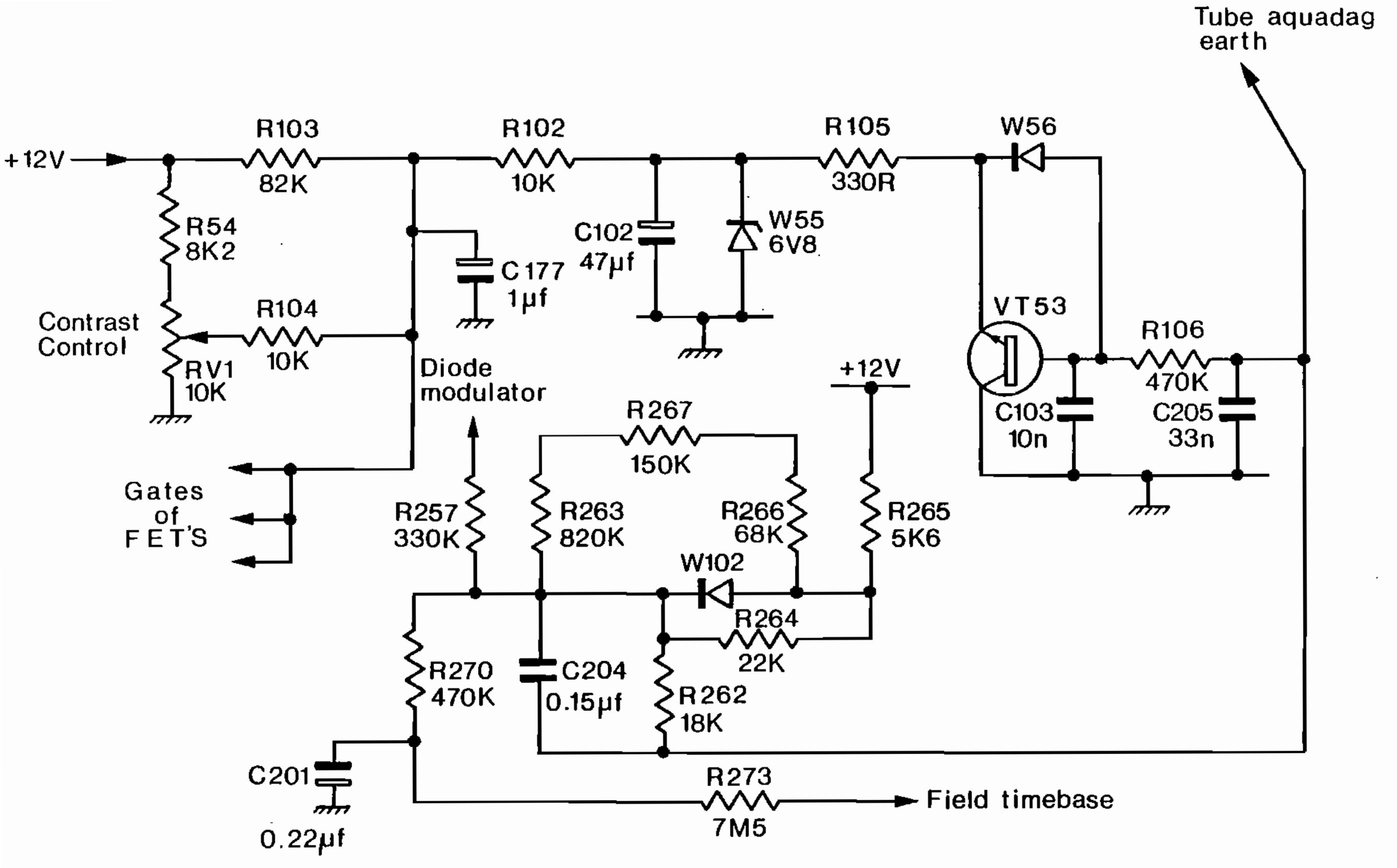


Fig.6c



Tube aquadag earth
+12V
R103
82K
R102
10K
R105
330R
W56
R54
8K2
C177
1µf
C102
47µf
W55
6V8
VT53
Contrast Control
R104
10K
RV1
10K
R106
470K
Diode modulator
+12V
C103
10n
C205
33n
R267
150K
Gates of FET'S
R257
330K
R263
820K
R266
68K
R265
5K6
W102
R264
22K
R270
470K
C204
0.15µf
R262
18K
C201
0.22µf
R273
7M5
Field timebase

Fig. 7

Structure of Characters

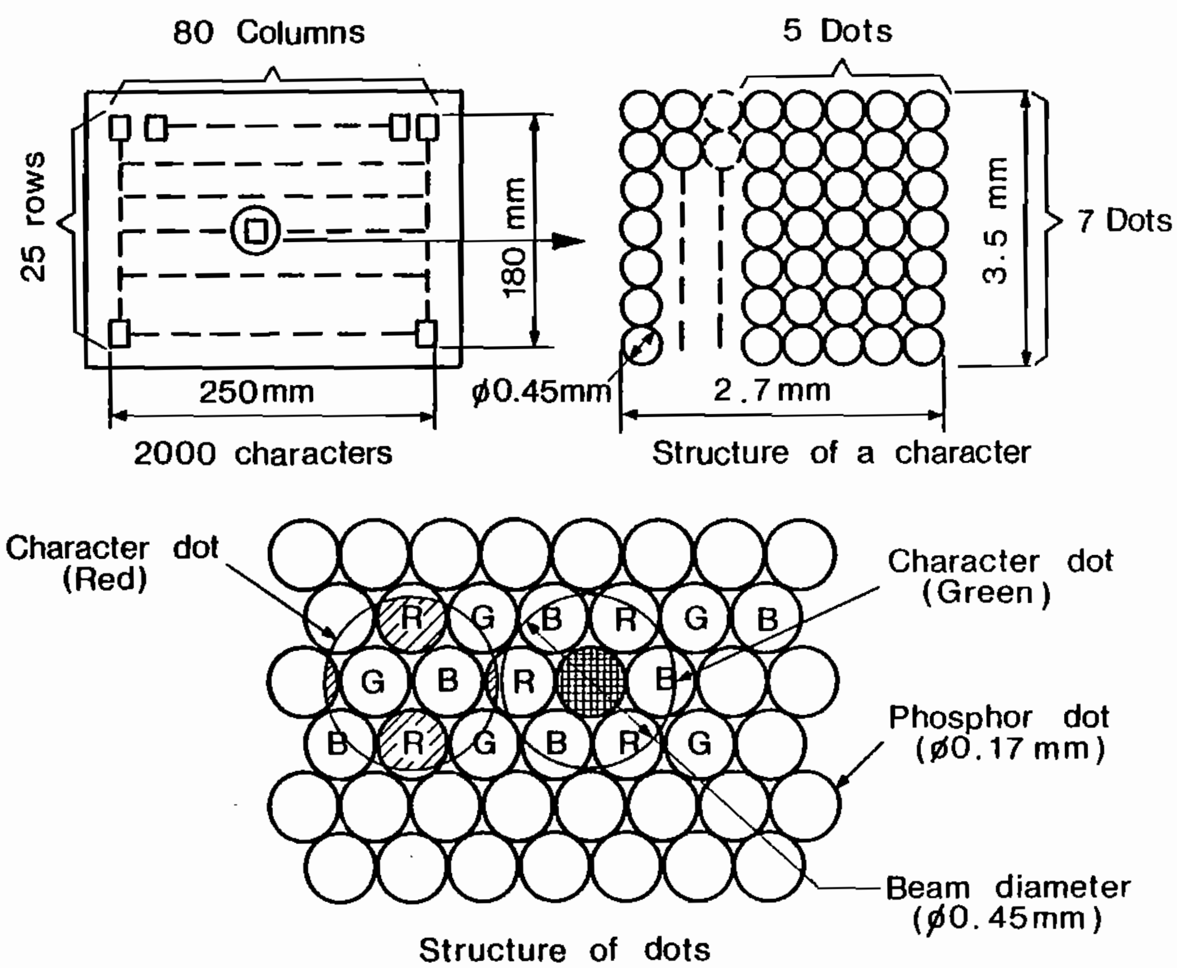


Fig. 8

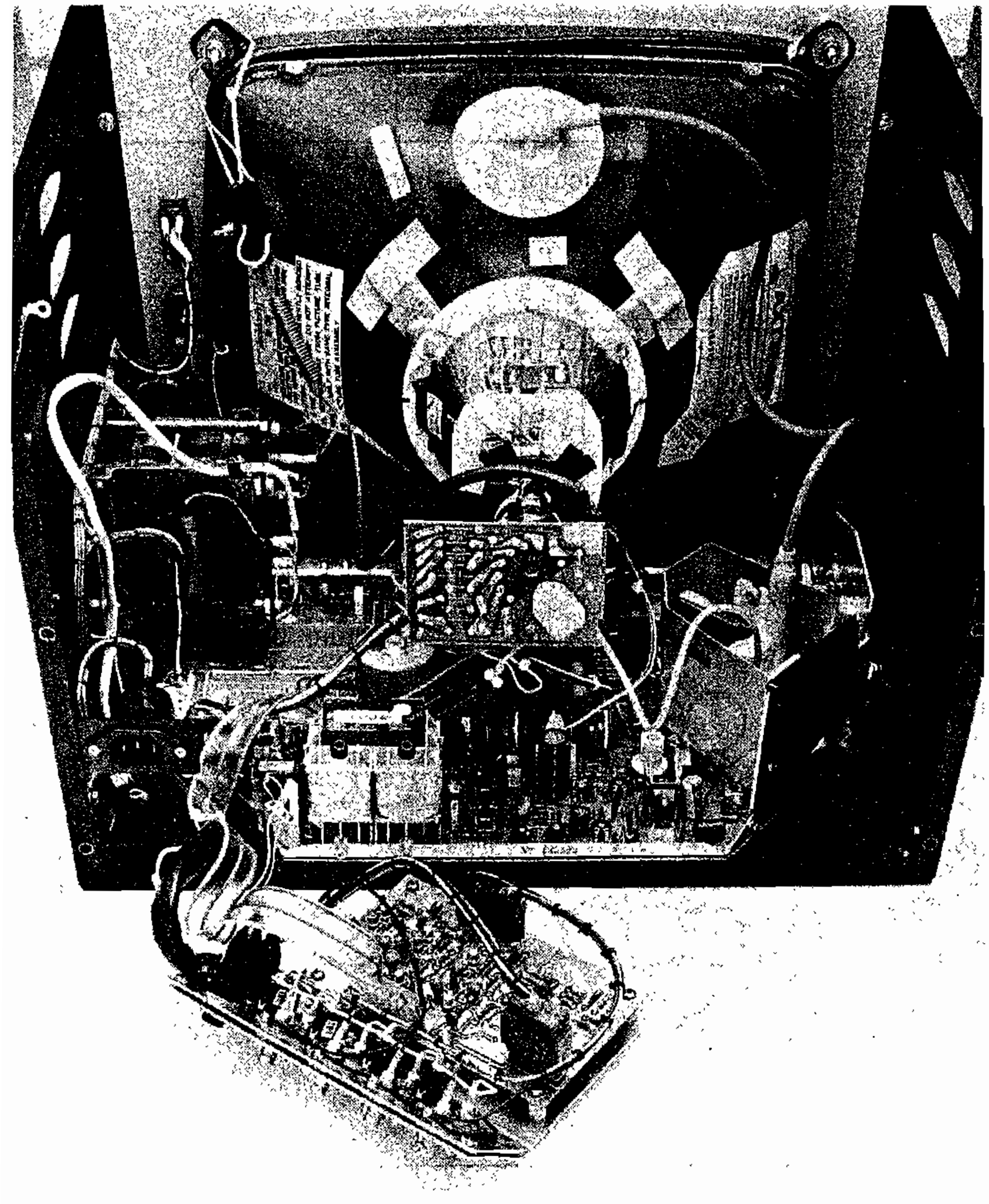


Fig.9

DL43