SECTION 7

WAVEFORM MONITOR MN6/501

Introduction

The MN6/501 is a waveform monitor intended for use in vision control rooms of studios that are equipped for one-man control. The monitor is designed to be very narrow and to have the same height as the Pye picture monitor type 2780. These two monitors can thus be mounted side by side to form a compact unit and the overall size of an array, such as is used in a control room, is kept to a minimum.

General Description

A narrow rectangular cathode-ray tube is used, mounted with its major axis vertical. The tube was intended for use with the major axis horizontal and therefore the video signal is applied to the X-plates. The maximum brightness of the tube is 10 foot-lamberts. The usable display is 4½ in. high by 1½ in. wide and is suitable for viewing at distances from 6 to 10 feet.

The time-base operates at field frequency and all the active lines of a television signal are displayed. The video signal is clamped at blanking level.

The monitor is used to check that signals corresponding to peak white in a televised picture are of the correct amplitude and that black level is correctly set. For this purpose a reference signal, corresponding to peak white, is generated during the time-base fly-back period and mixed with the video input signal to produce a cursor line at the top of the display. The position of this line can be adjusted relative to blanking level and its calibration is not affected by alteration of the gain control.

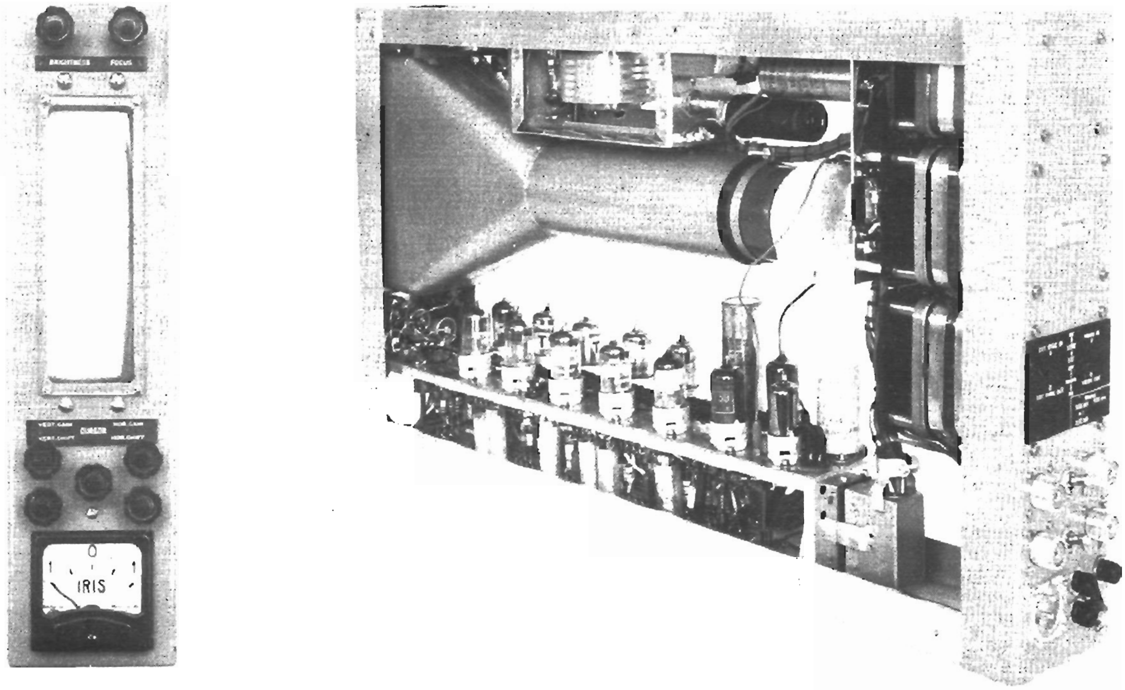

Fig. 7.1 MN6/501 : Front View of Unit and Oblique View, with Side Panels Removed

The monitor requires an input of either 1 volt p-p composite video signal or 0·7 volt p-p video signal only. Synchronising is achieved by sync pulses derived either from the composite signal or from an external source of standard mixed syncs (2 volt p-p).

In studios equipped for one-man operation the vision-control supervisor is able to adjust the iris settings of the camera lenses within a limited range of two stops. A remote indication of the iris setting is required in the vision control room and the MN6/501, situated beside the picture monitor, provides a convenient mounting for an iris meter. A meter, calibrated in half stops, is incorporated in the front panel of the waveform monitor and illuminated by means of an electro-luminescent panel. Some units have been issued without this facility.

The video and external-sync inputs of the monitor are duplicated to enable bridging connections to be made. A 75-ohm termination must be provided externally when required.

The power consumption of the monitor is approximately 75 watts.

Mechanical Details

The monitor is constructed in a frame consisting of front and rear panels joined by four L-section girders to which are screwed the covering panels. Fig. 7.1 shows two views of the MN6/501.

The video amplifier and waveform generators are constructed on a sub-chassis which is mounted in the bottom of the frame. All electrical connections to this chassis are made by an 18-way Painton plug and socket, with the exception of two video-signal leads to the base of the cathode-ray tube. The chassis can be removed for maintenance purposes by taking off the control knobs and releasing three screws.

The power supply equipment is screwed to the rear panel. It comprises a mains transformer with an attached panel carrying various associated components, a smoothing choke and a heater-supply transformer.

The cathode-ray tube is fitted in a screening can mounted on the front panel. The tube can be changed after first removing the connector from its base, then releasing four screws in the front panel and withdrawing the whole assembly from the frame.

The e.h.t. unit, constructed as a sub-assembly with side cover-plates, is held to the frame by screws at a position above the tube. The e.h.t. voltage is adjustable by a variable resistor, the knob of which is accessible after removal of a side cover panel from the monitor.

An astigmatism control, mounted between the e.h.t. unit and the front panel, is accessible through the top cover.

All external connections to the monitor unit are made through plugs and sockets mounted on the rear panel. The mains switch, sync-selector switch, iris-meter input plug and three fuses are grouped on the same panel.

The overall dimensions of the MN6/501 are $13\frac{1}{4}$ in. high, $3\frac{3}{8}$ in. wide and $24\frac{5}{8}$ in. long. The weight is 25 lbs.

Circuit Description Figs. 15 and 16

The circuit of the complete monitor is in two diagrams, Fig. 15 showing the operational stages and Fig. 16 giving details of the power-supply arrangements.

Video Amplifier Fig. 15

V1, a double triode, is used to mix the cursor signal with the video signal. V1a is fed with the video input signal from plug PLA while V1b is fed with cursor pulses from the pulse generator V10. The gain of V1b is stabilised by the use of a large amount of negative feedback obtained from the unbypassed cathode resistors R8 and R9. The two signals are mixed at the common anode connection to R3 and applied through C4 to the video amplifier V2.

V2 is a cascode amplifier, the gain of which can be adjusted by the variable resistor R14 in the cathode circuit. This controls the amount of negative feedback and is the *Vert. Gain* control. The output of V2 is coupled through C6 to the grid of the cathode follower V3.

The signal is clamped at V3 grid, during the period of the back porch, by the action of a conventional clamp circuit using V13 and blanking level is established at the voltage of the junction of R19 and R20. Sync pulses are not required in the display and they are reduced in amplitude by about 50 per cent by the clipping action of MR1; this reduces the signal-handling capacity required of the output amplifier V4 and V5. When negative-going sync pulses drive the cathode of V3 negative with respect to the voltage at the junction of R19 and R109, the diode MR1 conducts and C7 and C8 maintain the cathode at a constant voltage.

The output video amplifier uses two pentodes connected as a long-tailed pair. The video signal, with reduced-amplitude syncs, is applied to the control grid of V4 and the control grid of V5 is connected to the slider of R18, the vertical shift control (*Vert. Shift*). The output is taken from the anodes of V4 and V5 to two sockets mounted on top of the chassis, from where connection is made to the X plates of the cathode-ray tube by means of two wandering leads and plugs.

Waveform Generator Circuits Fig. 15

(*a*) *Sync Separator*

The input signal to the sync separator valve V6 is selected by switch S2 from either of the *Video In* and *Ext. Sync In* sockets. This signal is amplified and inverted by V6a and applied to the grid of V6b where the diode MR5 restores the positive-going tips of the sync pulses to earth potential. Since the cathode of V6b is biased positively, by connection to the cathode of V6a, the negative-going signal holds the valve cut off except for the duration of the sync pulses. Thus only sync pulses are developed at the anode of V6b; further information about sync separating stages is available from Television Engineering, Vol. 4. These pulses are fed to two pulse generators V7 and V11 and also to the grid of the cathode-ray tube, to black-out the trace for the duration of the sync pulses. This prevents confusion of the trace by the sync pulses during the period of the cursor pulse.

The negative-going sync pulses are applied via the integrating circuit R58 and C23 to the grid of V7a where negative-going pulses are developed at field frequency. V7a operates with zero bias and the field frequency pulses cut off the valve to produce positive-going pulses at the anode. These output pulses are differentiated by C24 and R61 and applied to the grid of V7b, which is operated with zero bias so that positive-going spikes, resulting from differentiation, are suppressed. The negative-going parts of the waveform cut off V7b anode current for a period dependent on the discharge time-constant of C25 and R62 plus R63. Positive-going pulses are produced at V7b anode and these are used to drive the time-base generator. They are used also as an input to the white-level cursor generator.

(*b*) *Sawtooth Generator*

The sawtooth generator is a conventional circuit in which the anode current of the triode V8 discharges C28 when the positive-going output pulses from V7b drive V8 into conduction; see Television Engineering, Vol. 3. The output from this circuit is used to drive the output time-base amplifier V9. This double-triode is connected as a long-tailed pair with the sawtooth waveform applied to V9a grid from the slider of R68, the *Hor. Gain* control. R74, the horizontal shift control (*Hor. Shift*), is connected between the grids of V9a and V9b to give differential adjustment of the bias.

(*c*) *Cursor Pulse Generator*

The output pulses from V7b are fed also to a conventional window stage using V10. The current in V10b is stabilised by the connection of its grid to the stabilised 85-volt supply which is developed across the stabiliser V12. The conduction current of V10b is adjusted by use of the *Cursor* control R37, which is in the common cathode circuit and this establishes the anode voltage of V10b when the valve conducts. The positive-going pulses from V7b drive V10a into conduction and raise V10 common cathode to a voltage sufficient to cut off the anode current of V10b. The output pulses from V10b anode are thus stabilised in amplitude.

(*d*) *Clamp Pulse Generator*

Pulses to operate the clamp diodes V13a and V13b are generated by V11. Negative-going sync pulses from the anode of V6b are differentiated by C11 and R40 and applied to the grid of V11a. To make the clamp inoperative when cursor pulses are being displayed, negative-going pulses from the anode of V10a are applied also to V11a grid. MR2 is used to restore the positive tips of the cursor-pulse waveform to earth potential so that the pulses hold V11a in the cut-off state and effectively gate out the sync input.

V11a operates with a low anode current because of the large cathode-bias resistor R42. Negative-going spikes, resulting from differentiation of the sync pulses, cut off the anode current of V11a to produce small amplitude negative-going pulses at the cathode. Positive-going spikes cause an increase in the anode current and so they are reproduced at the cathode. Thus, the output from V11a cathode consists of positive-going spikes, recurring at line frequency and which are gated out for the duration of the cursor pulses. These output pulses are applied to the grid of V11b through C14 and are squared off through clipping action by diode MR3. V11b operates as a conventional phase-splitter and its two outputs are fed to the clamp diodes V13a and V13b.

Power Supplies Fig. 18 (3)

The MN6/501 uses both 210-volt and 400-volt h.t. supplies which are unstabilised. The outputs of two 175-volt windings on mains transformer T1 are full-wave rectified and smoothed; the winding with the higher current rating provides the 200-volt supply. The 400-volt supply is obtained by connecting the two sources in series.

The e.h.t. supply is obtained by rectifying the output from an r.f. oscillator circuit which uses V14a, the output from which is stabilised by means of V14b. The grid-cathode resistor of V14b (R83) is common to both the resistor chain across the e.h.t. (R85—R94) and the resistor chain across the stabilised 85-volt positive supply (R80 ai ' R81). Thus two opposing currents flow in R83 and their difference determines the magnitude and polarity of the voltage on the grid of V14b. For example, when the current drawn from the e.h.t. supply increases, with a resultant fall in supply voltage, the voltage on the grid of V14b shifts in a positive direction and the anode current of V14b is increased. The fall in voltage at V14b anode effectively increases the h.t. supply to V14a, and increased output from the oscillator compensates for the additional load.

R81 is made adjustable and is used to set the e.h.t. voltage to 3kV.

Test Specification

The following apparatus is required :—
Avometer Model 8.
Television Test Generator TV/TG/1.
Electrostatic voltmeter to measure 3 kV.
Tektronix oscilloscope type 545 with :—
Plug-in unit type 53/54K,
Probe (10x, 10 Megohms, 8 pF) and
Probe (50x, 10 Megohms, 2·5 pF).
Dummy loads for h.t. supplies :—
H.T.1 8·2 kilohms (20-watt rating).
H.T.2 4 kilohms (10-watt rating).

N.B. Tektronix oscilloscope type 524AD may be used for all tests except that dealing with frequency response.

Power Supplies

Confirm that the primary tappings of both transformers are correctly set.

1. Disconnect both the 18-way Painton socket from the sub-chassis and the 400-volt supply from the e.h.t. unit. Connect the dummy loads.
2. Switch on and allow a warm-up period of one minute. Use the Avometer to check that voltages between pins of the Painton socket are as follows :—

Pins	*Volts*
1(+) and 18	395 ± 10
2(+) and 18	210 ± 10
4 and 5	6·6 ± 0·1
9 and 10 (iris-meter supply)	Mains input

3. Use the oscilloscope to measure the hum levels on the two h.t. lines. These should be :
   H.T. 1 1·5 volts p-p approximately.
   H.T. 2 0·25 volts p-p approximately.
4. Switch off, disconnect the dummy loads and re-connect both the 18-way Painton socket and the 400-volt supply to the e.h.t. unit.
5. Remove all valves from the sub-chassis with the exception of V12 and connect a 15-kilohm (1 watt) resistor between chassis and the 85-volt terminal on the e.h.t. unit.
6. Connect the electrostatic voltmeter between earth and the junction of R84 and R85 and place the *Brightness* and *Set E.H.T.* controls at the middle of their ranges.
7. Switch on and ensure that the voltage stabiliser V12 strikes. Use the Avometer to measure the voltage at the 85-volt terminal on the e.h.t. unit. This should be 85 volts ± 2 volts.
8. Adjust R81 to give a reading of 3 kilovolts on the electrostatic voltmeter. Turn the *Brightness* control between minimum and maximum settings and verify that the change in e.h.t. voltage is not greater than ± 50 volts. (Low output and poor regulation indicate that the oscillator is operating in a spurious mode. This can be checked by monitoring with the oscilloscope at pin 6 of valve V14 where there should be a sine waveform with a frequency of 100 k/cs and an amplitude of 400 volts p-p).
9. Switch off. Replace all valves and disconnect the 15-kilohm resistor. Switch on and allow two minutes for the monitor to warm up.
10. Connect a source of mixed syncs (2 volts p-p) to the *Ext. Sync In* socket and operate the *Sync* selector switch S2 to *Ext.* Connect a 75-ohm termination to the *Ext. Sync Out* socket.
11. Turn the *Cursor* control fully anti-clockwise and position the trace centrally on the screen with blanking level about 1 cm from the bottom. Set the *Vert. Gain* and *Hor. Gain* controls to give a display about 3·5 cm wide and 11·5 cm high.
12. Check that the *Focus* and *Astig.* controls can be set to their optimum positions with a margin of control on either side of these settings.
13. Check that the trace is free of obvious 100-kc/s modulation from the e.h.t. oscillator.

Video and Waveform Generator Circuits

14. Connect the Avometer between chassis and pin 7 of V9 and check as follows :

(a) Set the *Hor. Shift* control fully anti-clockwise. The meter should read not less than 20 volts.

(b) Set the *Hor. Shift* control fully clockwise. The meter should read not greater than 16 volts.

This range of control should take the trace well off the cathode-ray tube screen on either side.

15. Connect the Avometer between chassis and pin 2 of V5. The voltage at this point should be approximately 34 volts (with the controls set as detailed by item 11). The change in voltage over the full range of the *Vert. Shift* control should be not less than 20 volts and should be sufficient to move the trace downwards from a position with blanking level 3 cm from the bottom of the screen to one where blanking level is off the screen.
Re-position the display as explained in item 11.
16. Monitor at pin 1, V6 with the oscilloscope, using the 10x, 10-megohm, 8-pf probe. The inverted display of mixed syncs should have an amplitude of 40 volts p-p.
17. Monitor at pin 6, V6. The displayed mixed syncs should have an amplitude of 50 volts p-p.
18. Monitor at pin 1, V7. The positive-going field frequency pulses should have an amplitude of 140 volts p-p.
19. Trigger the oscilloscope from an external source of field trigger pulses while monitoring at pin 6 of V7. The delayed positive-going pulses should have an amplitude of 140 volts p-p and be delayed by 450 μs ± 50 μs from the start of the field trigger pulses. The displayed pulse width should be 650 μs ± 50 μs and can be adjusted, if necessary, by selection of R62.
20. Monitor pin 1, V8. The amplitude of the displayed sawtooth waveform should be 13 volts p-p.
21. Monitor pin 1, V9. Check that the *Hor. Gain* control is set to give a trace about 3·5 cm wide. The amplitude of the sawtooth waveform displayed on the oscilloscope should be 68 volts p-p.
22. Monitor pin 6, V9. The displayed waveform should measure 56 volts p-p.
23. Adjust the *Hor. Gain* control and confirm that at minimum and maximum settings the waveforms for items 21 and 22 have p-p amplitudes less than 15 volts and greater than 95 volts respectively.
N.B. Spikes appear on the waveform when the control is at minimum and flattening of peaks is evident at the maximum setting.
Reset the *Hor. Gain* control to give a trace 3·5 cm wide.
24. Monitor pin 1, V10. The displayed negative-going gating pulses should have an amplitude of 32 volts p-p.
25. Monitor pin 6, V10. The amplitude of the displayed positive-going cursor pulses should be variable, by use of the *Cursor* control, over a range greater than 7-10 volts p-p.
26. Monitor pin 1, V11. Operate the oscilloscope time-base successively at both line and field frequencies to check that the positive-going pulses have an amplitude of 20 volts p-p and that they are gated out for the duration of the cursor pulses.
27. Monitor pin 5, V13. The displayed negative-going clamp pulses should have an amplitude of 20 volts.
28. Monitor pin 7, V13. The amplitude of the positive-going clamp pulses should be 15 volts.
29. Connect the output of the TV/TG/1 to the *Video Input* socket and set the generator controls to give an output of *Sync and Lift* at an amplitude of 1 volt p-p. Connect a 75-ohm termination to the *Video Out* socket and operate the *Sync* selector switch S2 to confirm that neither the cursor not the time base are affected by the change of triggering pulses. Set S2 to *Int.*
30. Monitor across the *Video Out* socket termination with the oscilloscope and set the lift signal from the TV/TG/1 to 0·7 volts. Adjust the *Cursor* control on the MN6/501 to make the displayed cursor line coincident with the lift signal. Adjust the *Vert. Gain* control to restore the display to a height of 11·5 cm.
31. Monitor pin 1 of V1. The display should have an amplitude of 1·8 volts p-p and will show the cursor pulses following field blanking.
32. Monitor pin 8, V3. The amplitude of the display should be 4·75 volts p-p with the relative amplitude of the sync pulses reduced by about 50 per cent. Adjust the *Vert. Gain* control and confirm that the p-p amplitude of the display can be varied from less than 3·5 volts to greater than 6·5 volts. Reset the *Vert. Gain* control to give a display 11·5 cm high.
33. Monitor the output from V4 at the red socket on the chassis. The display amplitude should

VOLTAGE MEASUREMENTS

Operational Stages (Fig. ~~15~~ 2)

Valve	*Anode*	*Cathode*	*Screen*	*Voltmeter Range(s)*
V1a	78	2·1		250/10
CV2492				
V1b	76	9·5		250/25
V2a	172	86		250
CV2492				
V2b	86	3·1		250/25
V3b	85	33		250/100
CV491				
V4	320	35	208	1000/100
CV5060				
V5	220-105	35	205	1000/100
CV5060				
V6a	150	3·8		1000/10
CV2492				
V6b	200	3·8		1000/10
V7a	62·5	0		100
CV455				
V7b	43	0		100
V8a	25	0		100
CV455				
V9a	155	23·5		250/100
CV492				
V9b	142	23·5		250/100
V10a	208	86		1000/250
CV492				
V10b	200	86		1000/250
V11a	156	5·7		250/10
CV2492				
V11b	152	5·2		250/10

Voltage at the junction of R21 and R22 is 32 volts (250-volt range).

Power Supplies (Fig. ~~16~~ 3)

V14 CV5042 — Maximum E.H.T. voltage available at the junction of R84 and C35 is 5kV (approximately).

H.T.1 400 volts (Pin 1 SKTA)
H.T.2 210 volts (Pin 2 SKTA)

be 265 volts p-p.

34. Monitor the output from V5 at the black socket on the chassis. The display amplitude should be 245 volts p-p.

Frequency Response

35. Switch the TV/TG/1 to *Pulse Signals, Spike 1* with no lift. Measure the rise time of the spikes at both output sockets, by means of the oscilloscope and the 50x, 10-Megohm, 2·5 pF probe. It should be not greater than 0·8 μs.

Clamp

36. Switch the TV/TG/1 to *Pulse Signals* with no lift. Check that the clamp operates satisfactorily when the *Pulse Signal* switch is moved to any of its six positions.

37. Switch the TV/TG/1 to *Sync and Lift*. Insert 3 dB attenuation in the 1-volt p-p signal feed to the MN6/501 and check that neither the clamp not the time base are affected.

Valve Data

The accompanying table gives typical voltages as measured with an Avometer Model 8. These readings were obtained with no signal applied to the monitor, but with the controls set to give a correctly positioned display.

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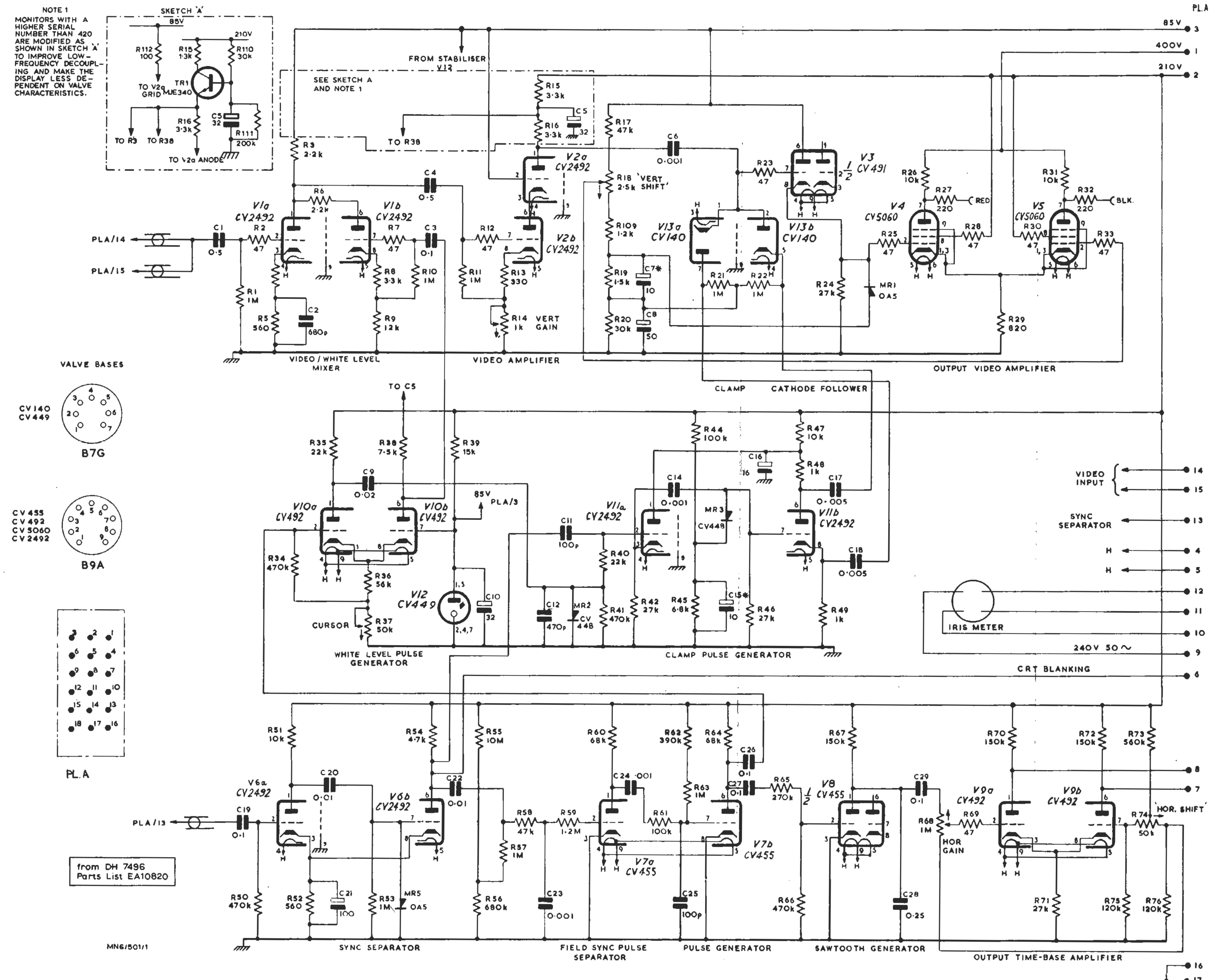
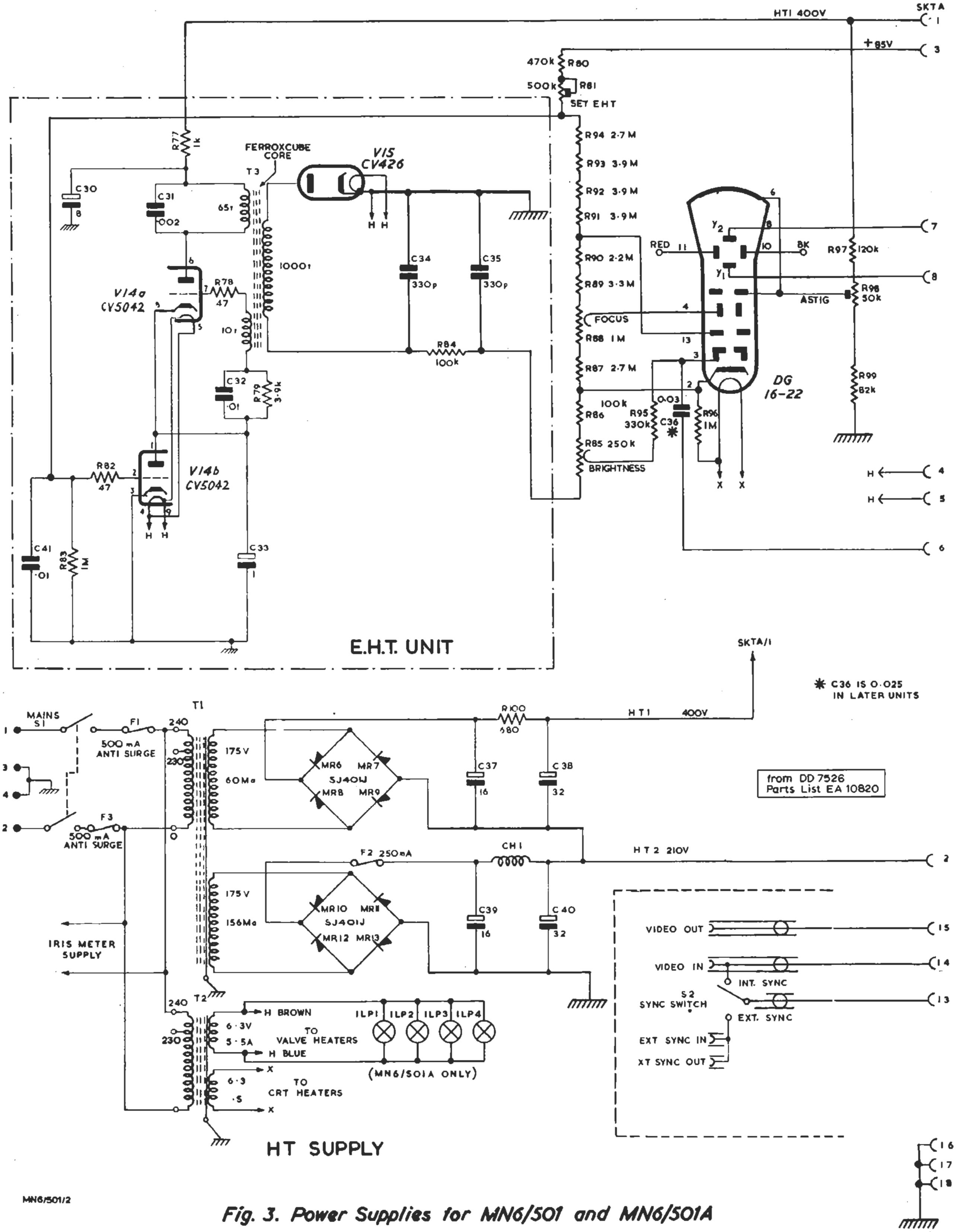


Fig. 2. Waveform Monitor MN6/501 Circuit

* IN LATER VERSIONS C7 & C15 ARE 8µF



MN6/501/2

Fig. 3. Power Supplies for MN6/501 and MN6/501A