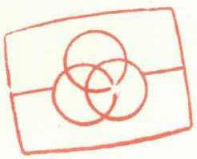
Valkonet

PHILIPS



manual

double trace storage oscilloscope **PM 3251**

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LIST OF CONTENTS

FIGURES

GENERAL INFORMATION

I. INTRODUCTION

The PM 3251 (storage version of the dual-trace 50 MHz general purpose oscilloscope PM 3250) is equipped with a PHILIPS post-accelerator half-tone storage tube type L14-110GH.
The service life of this tube is comparable to that of a conventional cathode ray tube, and its storage element is not subject to damage due to high display intensities.

Waveforms are stored in the PM 3251 by using a conventional electron gun assembly to form a charge pattern on the surface of a storage layer. This pattern can be maintained for a considerable period of time, even when the apparatus has been switched off.
The length of time that a stored image remains displayed depends upon the degree of display brightness used, and can be longer than two hours. It is possible to store several single shot waveforms in order to display them simultaneously. An erase facility enables stored information to be cancelled immediately at will.

The PM 3251 also incorporates a feature which enables display persistence to be varied over a wide range. This enables a stable display of repetitive slow-speed signals to be displayed without flicker effects. The variable persistence feature also enables fast h.f. signals to be displayed. In this case, several cycles are used to develop the image on the memory layer so that a clear display can be obtained. Such displays may be obtained using signals with repetition rates as low as one cycle per minute. Single shot signals which are normally too fast for display by a conventional oscilloscope may be means of a 'max write' facility. Because of the high degree of sensitivity involved in this mode of operation, display quality is slightly degraded.
In addition to the storage and variable persistence modes, the PM 3251 may be operated at the normal persistence of the P31 screen phosphor. The performance of the oscilloscope is exactly the same as the basic PM 3250.

The majority of electrical and mechanical units fitted to the PM 3251 are fully interchangeable with those of the PM 3250.
Both oscilloscopes share a common technical specification, with the exception of the PM 3251 storage and variable persistence features.
For front panel controls see Fig. 1.

II. TECHNICAL DATA

Numerical values stated in this section serve largely as a guide since they represent the characteristics of an average instrument.
The remainder of the technical data is as stated in the PM 3250 manual.

DISPLAY

Cathode ray tube	Post-accelerator, half-tone storage tube. 8 kV accelerating potential and P31 phosphor. Internal graticule.
Persistence (normal mode)	1.0 µs to 1 ms (i.e. natural persistence of P31 phosphor).
Persistence (variable mode)	From less than 0.3 s to more than 3 min
Graticule	8x10 div internal graticule mark marking (1 div = 0.9 cm)

STORAGE

Storage time (minimum brightness)	Greater than 2 hours
Storage time (maximum brightness)	Greater than 15 min
Writing speed (variable persistence mode)	Greater than 100 div/ms
Writing speed (Max write mode)	Greater than 1.2 div/µs
Erasure	Push button enables erasure to be made in less than 500 ms

III. DESCRIPTION OF THE BLOCK DIAGRAM (Fig. 2)

A. MAIN MULTIVIBRATOR

The main multivibrator produces a 2 kHz square wave signal which is used to drive the flood gun and persistence control circuits.

B. FLOOD GUNS CONTROL CIRCUIT

The flood guns control circuit includes a variable duty multivibrator which is controlled by the storage brightness potentiometer R18'. Square wave pulses are passed to the flood gun accelerators when the oscilloscope is in the STORE mode, and these acts as the display brightness signal (See Fig. 3). In the variable persistence mode, the control circuit holds the flood gun accelerators at a constant level.

C. VARIABLE PERSISTENCE CONTROL CIRCUIT

The variable persistence control circuit enables a series of automatic erasure pulses to be fed to the storage mesh in order to extend the display persistence (See Fig. 4). The duty cycle of the automatic erasure pulses (and hence the amount of persistence) is determined by potentiometer R18".

D. ERASE CIRCUIT

The erase circuit is used to generate one discrete erasure cycle (See Fig. 5) when the ERASE button is operated. This circuit is only operable provided that the oscilloscope is in its variable persistence mode.

E. WRITE CONTROL CIRCUIT

The write control circuit is used to automatically cut off the writing gun during erasure and storage display periods.

F. MAX WRITE CIRCUIT

The max write circuit provides means by which the erase cycle pulse can be modified in amplitude. The change in amplitude results in the memory mesh becoming extremely sensitive so that very fast single shot signals may be displayed.

IV. OPERATING INSTRUCTIONS

With exception of the typical storage controls, reference has to be made to the 'Operating Instructions' in the Manual of the basic PM 3250 version.

- Use as a normal oscilloscope.
  Set the PERSIST.-STORE control knob to position : NORMAL.

- Variable persistence.
  With the control knob in the PERSIST. range a certain persistence of the display is obtained.
  The duration of the persistence is increased by turning the knob clockwise in the PERSIST. range (the green overall haze showing at short persistence settings does not influence the correct operation of the cathode ray tube).
  Depending on the persistence setting, the intensity must be controlled to avoid 'blooming' of the display.

  When displaying a low frequency signal, the persistence can be set to suppress any flickering of the display.

  When a signal with a low repetition rate and a short rise-time is displayed, the persistence can be set in order to fill up the trace so that a clear, steady display is obtained.

  When single-shot phenomena are displayed, the persistence control knob must be in the fully-clockwise position of the PERSIST. range.
  Some trial settings of the INTENS. and FOCUS knobs may be necessary.
  With the SET READY push-button as well as with the ERASE push-button, it is possible to set the time-base circuit for a single shot.
  Several single-shot phenomena can be displayed below each other, when after each shot the POSITION control is set to a different position (the dial printings near the POSITION controls are not calibrated; they serve only for general information).

- Max. write.
  The writing speed can be increased by a factor 10, by pushing the MAX. WRITE button (normally required only for short sweep times).
  The Max. write mode is only functioning when, after operation of the MAX. WRITE button, the ERASE button is pressed.

- Erase.

  A display is erased by pressing the ERASE button (only when the control knob is in the PERSIST. range).

- Store.

  A display obtained in the PERSIST. mode can be stored by turning the control knob to the STORE range (now the writing gun of the cathode-ray tube is switched-off).

  The brightness of the stored display is increased by turning the intensity knob clockwise; however, the storage time is limited at higher brightness levels (see 'Technical data').

  When the mains voltage of the oscilloscope is switched-off, the display remains stored (without showing) for at least several days.

  Note, that switching on the instrument when the cathodes of the c.r.t. are still warm, disturbs the stored display (so wait at least 5 minutes).

SERVICE INFORMATION

V. CIRCUIT DESCRIPTION

A. INTRODUCTION

This section of the Appendix describes the various control and display circuits which are exclusive to the PM 3251 storage oscilloscope. The section also details those modifications which have been made to PM 3250 circuits in order to make them suitable for the PM 3251.
Most of the additional circuitry for this storage version has been located on the storage control unit, fixed over the time-base units, and on the flood gun filament supply unit, mounted behind the vertical output amplifier unit.
The main circuit description is preceeded by an explanation of the memory tube, as this will assist the reader in understanding the funtion of the various control circuits.

B. MEMORY TUBE

The PHILIPS memory tube type L14-110GH contains a writing system which comprises an electron gun and deflection electrodes which are identical to these of a conventional cathode ray tube.
The memory tube also houses two flood gun assemblies which are mounted just forward of the deflection plates, an electrostatic collimator, and storage and collector meshes which are located near to the screen. Unlike a conventional cathode ray tube, the screen phosphor is metallized in order to allow a post accelerator potential of 5.6 kV to be applied.

The rear (cathode) side of the storage mesh is coated with magnesium fluoride which is a material having excellent insulation and secundary emission properties. When this material is hit by electrons having an energy exceeding 40 electronvolts, its secundary emission ratio is higher than 1 (which means that a higher number of electrons is emitted than the number that is arriving). A relatively-positive charge pattern can therefore be built up by the writing gun and maintained on the surface of the magnesium fluoride. This positive charge pattern can be used to admit electrons to the screen phosphor and so reproduce the stored waveform on the screen.

Since magnesium fluoride is an insulator, a capacitive coupling is formed between the charge pattern present at the surface layer and the metal of the storage mesh. This capacitive property enables erasure of a stored pattern and the preparation of the mesh prior to the storage of a new pattern.
Immediately prior to recording a waveform, the whole surface layer of the storage mesh is brought to a uniform negative potential by means of an erase cycle. The conventional writing system is then used to write the required waveform on the storage mesh. The path on the storage mesh which is traversed by the electron beam is charged to a potential which approaches zero volts; this relatively-positive image area allows electrons to be attracted by the high potential which excists on the screen layer. The remaining (negatively charged) areas of the storage mesh repulse the flood gun electrons so that they may be taken by the collector mesh.

The collector mesh, situated to the rear (cathode) side of the storage mesh, is held at a positive potential of 100 V.
This positive potential serves to accelerate electrons towards the storage mesh and also to capture those electrons which are repelled.

The two flood gun assemblies, located just forward of the conventional deflection plates, are used to emit sprays of low-energy electrons.
The collimator, which consists of metallic deposit on the sides of the tube glass, is used to form the flood gun electrons into an evenly-distributed stream in order to obtain an even display. The stream is accelerated towards the screen by the collector mesh whose apertures are much larger than those of the memory mesh. Having passed through the storage mesh, the electrons are further accelerated by the post accelerator potential (5.6 kV) which exists on the metallized screen layer.

C. FLOOD GUN ACCELERATORS CONTROL CIRCUIT

When the oscilloscope is operating in the STORE mode, the flood gun accelerators are supplied with a variable pulse width signal which controls the display brightness, see Fig. 3. The flood gun control circuit (see Fig. 8) includes a variable duty cycle multivibrator (TS1903, TS1904, TS1906 and TS1907) which is driven by a 2 kHz signal obtained from the main multivibrator (TS1901 and TS1902). The percentage duty cycle is determined by potentiometer R18', and the resulting signal is used to provide display brightness in the storage mode.

A positive pulse coming via GR1901 causes TS1904 to conduct whilst the remaining three transistors of the variable duty cycle multivibrator are cut off. After a period of time (determined by the setting of R18') TS1903 is returned to its conductive state and TS1904 is cut off.
The collector level of TS 1904 is then determined by the voltage across C1903, R18' and R1918; this level sets the point at which TS1906 and TS1907 are switched on. In the event of a positive pulse appearing at the base of TS1904 before TS1906 and TS1907 switch on, the previous cycle is over-riden. The circuit operation therefore provides continuous selection of the duty cycle from 1 % to 100 %.
The output of the variable duty cycle multivibrator is inverted by TS1908, and is then used to control the emitter follower TS1909 which supplies the flood gun accelerators. An emission of electrons takes place whenever the output of TS1909 becomes positive with respect to the flood gun cathode.

If the switch SK31 is moved from its STORE position, the +12 V supply is removed from the base of TS1908. This results in TS1908 being cut off. The variable duty cycle waveform is consequently blocked and emitter follower RS1909 supplies a continuous level which is positive with respect to the flood gun cathodes. An uninterrupted stream of electrons is therefore emitted in both 'Normal' and 'Variable Persistence' modes.

D. WRITE CIRCUIT CONTROL

When a stored waveform is being displayed, it is important that no further displays are written on the memory mesh inadvertently. In order to prevent this, the conventional writing system is disabled.
With switch SK31 set to its STORE position, a +12 V supply is connected via GR1918 and R1968, to the base of TS1918.
Consequently, transistors TS1918 and TS1919 conduct and a current is fed to the write circuit in order to cause the writing gun to be cut off.

If an erase cycle is initiated by closure of the ERASE switch SK30, the writing gun is disabled by a current which is supplied to the base of TS1918 by way of GR1917 and R1966.
Upon release of the ERASE switch, a 600 ms pulse is applied to the base of TS1918 (via GR1916 and R1962) in order to hold the writing circuit in its disabled condition until the conclusion of the erase cycle (see para F).

E. VARIABLE PERSISTENCE CONTROL CIRCUIT

When switch SK31 is set to its PERSIST position, potentiometer R18" may be used to vary display persistence over a range of from less than 0.3 sec. to more than 10 min. This persistence control is obtained by using a series of pulses in order to periodically 'wipe' the written signal from the memory mesh.

The wiping pulses are derived from the 2 kHz square wave output of the main multivibrator, which also drives the flood gun anode control circuit. The square wave signal is fed via TS1911 to a variable integrator circuit (C1904, R1934, R18"). The integrated signal is used to switch transistor TS1912, the cut off periods of which are dependent upon the setting of R18". Pulse amplitude set by trimmer R1944 (R1946 in the MAX WRITE mode).

The wiping pulses are brought to a -50 V level by means of the clamping circuit (C1906 and GR1911) and are then applied to the storage mesh.

F. MANUAL ERASE CYCLE

Operation of the ERASE switch SK30 results in the application of a 100 V potential to the storage mesh, provided that switch SK31 is in its PERSIST position. At the same time a d.c. potential is applied to diode GR1914 causing capacitors C1907 and C1908 to charge.

Immediately upon release of switch SK30, capacitors C1907 and C1908 discharge, causing TS1916 to produce a pos. 600 ms pulse and TS1917 a pos. 200 ms pulse. The pos. 600 ms pulse is inverted by TS1914 prior to being applied, together with the 200 ms pulse, to TS1913. Transistor TS1911 is maintained in a bottomed condition throughout the 600 ms period via R1938 and R1939, so that the 200 kHz square wave input to the variable persistence circuit is interrupted. Normally, TS1913 is bottomed by the base current flowing via R1943 and GR1908. During this erase period, TS1913 conducts for 200 ms, and is switched off for the remaining 400 ms. Transistor TS1912 is then also switched off and its collector level rises to approximately 10 V. The resulting erase cycle, illustrated in fig. 5 , firstly destroys any data which may be stored on the memory mesh by bringing its surface layer to a potential of 100 V. When the button is released, the surfaced potential falls towards zero volts. After 200 ms, the storage mesh is raised to 10 V and is maintained at that level for a further 400 ms. The surface layer consequently follows, due to capacitive coupling, and is raised to 10 V, but there is an immediate decay in the surface layer potential due to the reception of flood gun electrons.

Because of this, the trailing edge of the erase cycle waveform causes the surface layer to be reduced to a negative 10 V. The erase cycle is then complete and the memory mesh is fully prepared to accept a new waveform for storage.

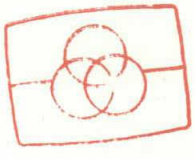
G. MAX WRITE MODE

As stated in the previous paragraph, the memory mesh surface potential is -10 V immediately after the erase cycle. The conventional electron gun assembly which is then used to write a fresh waveform must charge the surface to a storage threshold of approximately -5 V if the stored information is to be written on the screen. If the written waveform does not charge the surface to a sufficient potential (-5 V) the flood gun electrons will not be attracted by the post accelerator potential which exists at the screen layer.

Operation of the MAX WRITE switch causes R1946 to be connected between earth and the collector of TS1912. This reduces the amplitude of the erase cycle waveform by approximately half the original value. After erasure in the MAX WRITE mode, the memory mesh surface potential is raised to almost the threshold level. Writing speed is consequently increased significantly for fast single shot signals. This mode of operation degrades the contrast quality (because flood gun electrons may penetrate the memory mesh) so that it is only suitable for very fast single shot recording processes.

H. NORMAL OPERATION

With switch SK31 set to NORMAL, the oscilloscope may be operated as a conventional instrument. For this purpose, a -90 V potential is connected via the contacts of switch SK31 to the memory mesh. The electrons emitted from the flood guns are too slow to be accelerated through the meshes whereas the relatively fast electrons of the writing system may be passed through to the screen layer.



VI. VARIOUS ADJUSTMENTS

In this chapter only those adjustments will be discussed which are additional to the basic PM 3250 version.

All additional adjustment controls are located on the variable persistence and storage control unit (See Fig. 6). Only the flood gun filament voltage is adjusted on the relevant supply unit behind the vertical output amplifier unit.

When all potentiometers on the variable persistence and storage control unit must be adjusted (e.g. when a new unit is mounted) first set all potentiometers of this unit to the middle position and turn the "Intens" knob on the front panel fully anti-clockwise to prevent any possibility of damaging the cathode ray tube caused by too high brightness of the trace (or spot).

a. Flood gun filament voltage.
This voltage must be 6.3 V (d.c.) and can be measured at the flood gun supply unit connector (See Fig. 7).
If necessary, adjust this voltage with R1276 (on the flood gun supply unit).

b. Variable persistence pre-adjustment (selecting resistor R1934).
- Set the "Persistence-Store" knob to position maximum persistence (against the "Store" position).
- "Max. Write" knob not depressed.
- Connect an oscilloscope to the positive side of C1906 (See Fig. 6).
- R1934 must have a value somewhat higher than the value at which the pulses are disappeapring.
When no oscilloscope is available R1934 can be selected to a value somewhat higher than the value at which the green back-ground haze on the screen of the PM 3251 is disappearing.

c. Flood gun bias pre-adjustment.
The voltage between grid and cathode of each flood gun must be 0.5 V (grid negative with respect to cathode).
- The bias on G1' can be measured between the wiper of R1767 and point 20 of the connector, and adjusted with R1767 (See Fig. 6).
- The bias voltage on G1" can be measured between the wiper of R1754 and point X of the connector, and adjusted with R1754.

- For fine adjustment of the flood guns refer to point d.3.

d. Screen-rim effects.

1. - "Persistence-Store" knob in positions minimum persistence.
   - "Intensity" knob in position minimum intensity.
   - Adjust R1976 so, that when the "Erase" button has pressed, just no rim effects are visible on the screen and the back ground haze is as smooth as possible.

2. - "Persistence-Store" knob in position maximum persistence (against "Store" position).
   - "Intensity" knob in position minimum intensity.
   - Adjust R1944 so, that when the "Erase" button has been pressed, the screen just remains dark (over the whole surface).

3. - Press knob "Max. Write".
   - "Persistence-Store" knob in position maximum persistence.
   - "Intensity" knob in position minimum intensity.
     In this mode both clouds of the flood gun electrons are recognizable on the screen.
   - Adjust R1946 so, that when the "Erase" button has been pressed, the structure of the storage mesh is just visible on the screen.
   - The darker cloud must be adjusted to the same intensity as the other one with R1754 or R1767 (R1754 = right hand side cloud; R1767 = left hand side cloud).
     If necessary first adjust both potentiometers according to point c.
     The grid (G1) of the flood guns may not be positiv with respect to the flood gun cathodes.
   - Adjust R1977 so that an optimum part of the screen is covered. With this adjustment one has to compromise between screen-rim effects and covered screen surface.

VII. LIST OF ADDED OR MODIFIED COMPONENTS

Item	Code number	Description
B1	5322 131 24012	Storage cathode ray tube L14-110GH
GR1231	5322 130 34136	Diode BY187
R18	5322 102 34002	Potentiometer 2x22 kΩ, spec. version
SK13,29,30	5322 276 34006	Switch assembly
SK31	5322 273 54013	Rotary switch
T1201	5322 146 34017	Supply transformer
T1202	5322 142 64004	High-Tension transformer
U39	5322 218 64015	High-Tension rectifier assy.
-	5322 455 84003	Front plate

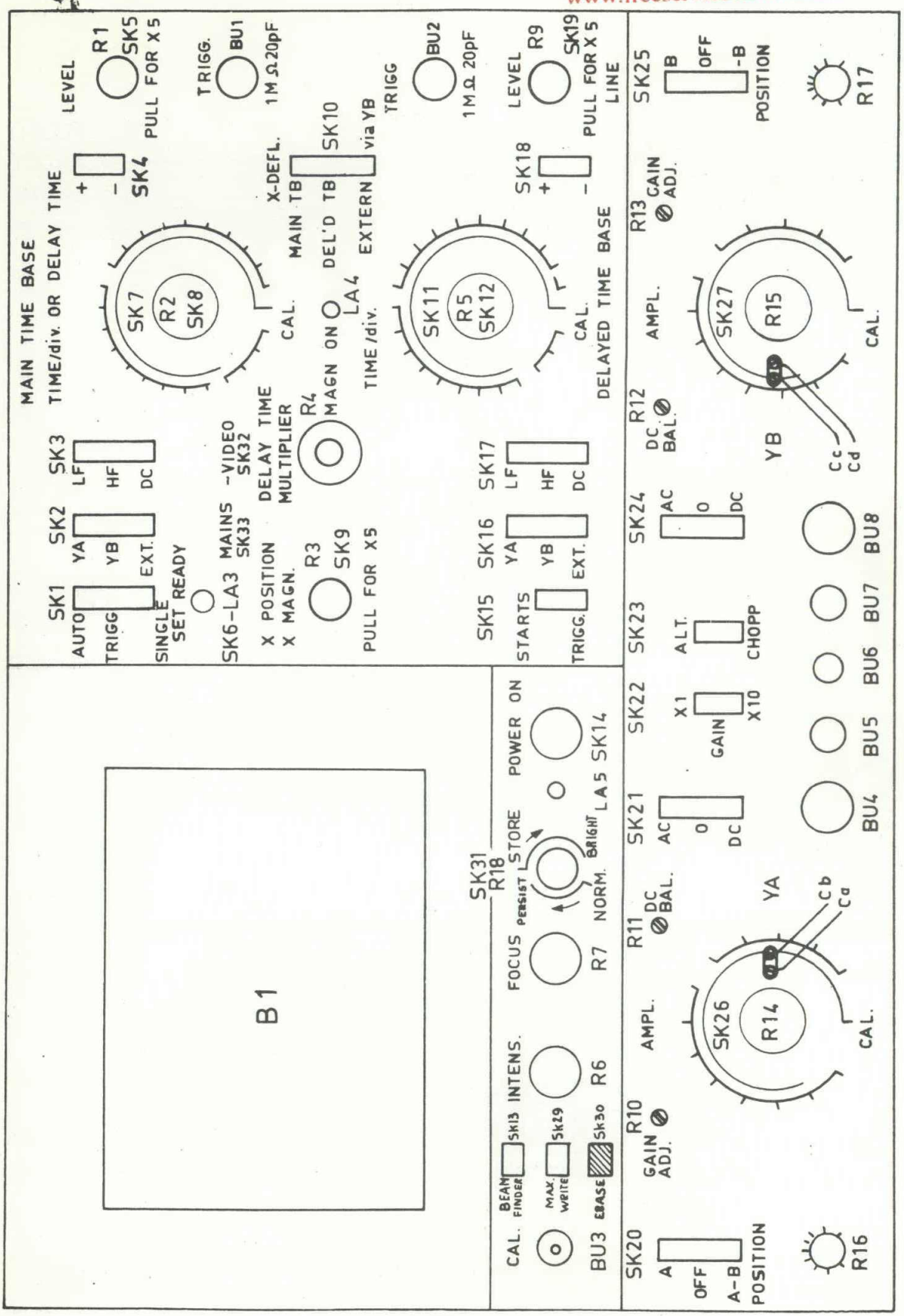
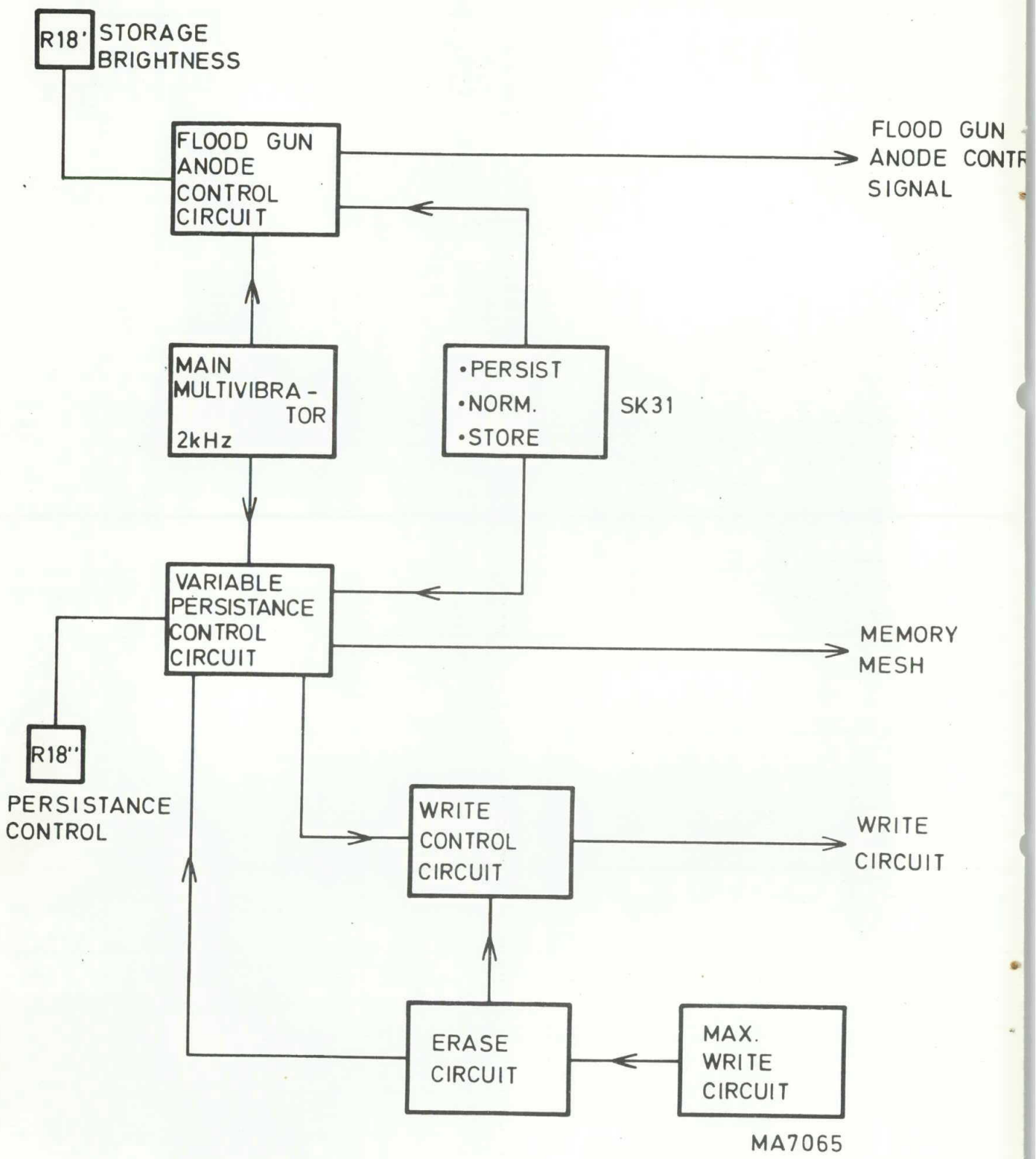
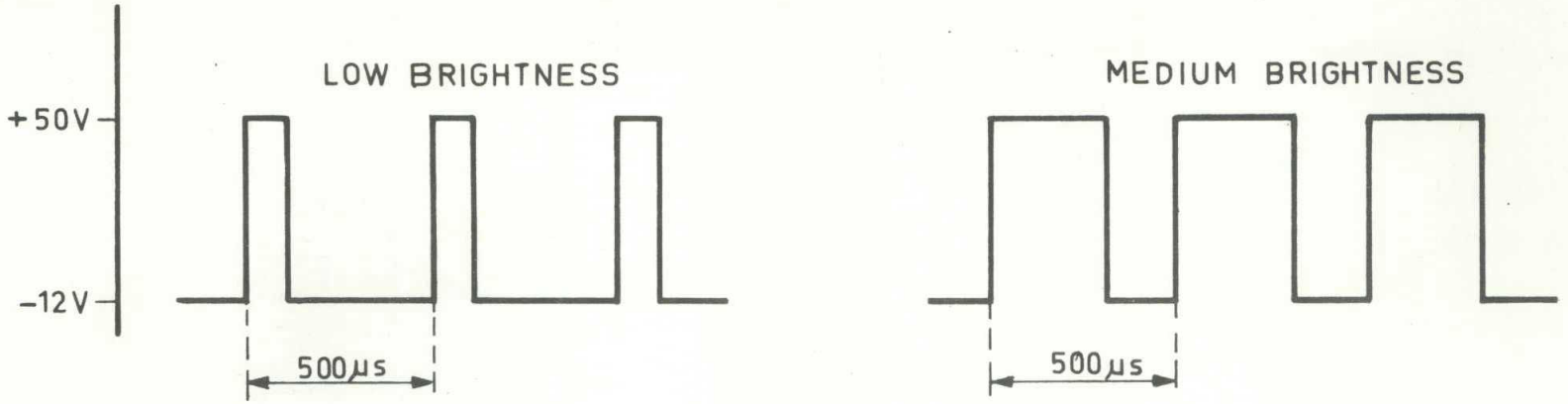


Fig. 1



BLOCK DIAGRAM OF STORAGE AND PERSISTENCE CONTROL CIRCUIT

Fig. 2



POTENTIAL WITH RESPECT TO FLOOD GUN CATHODES
(FLOOD GUN CATHODE VOLTAGE = -50V)

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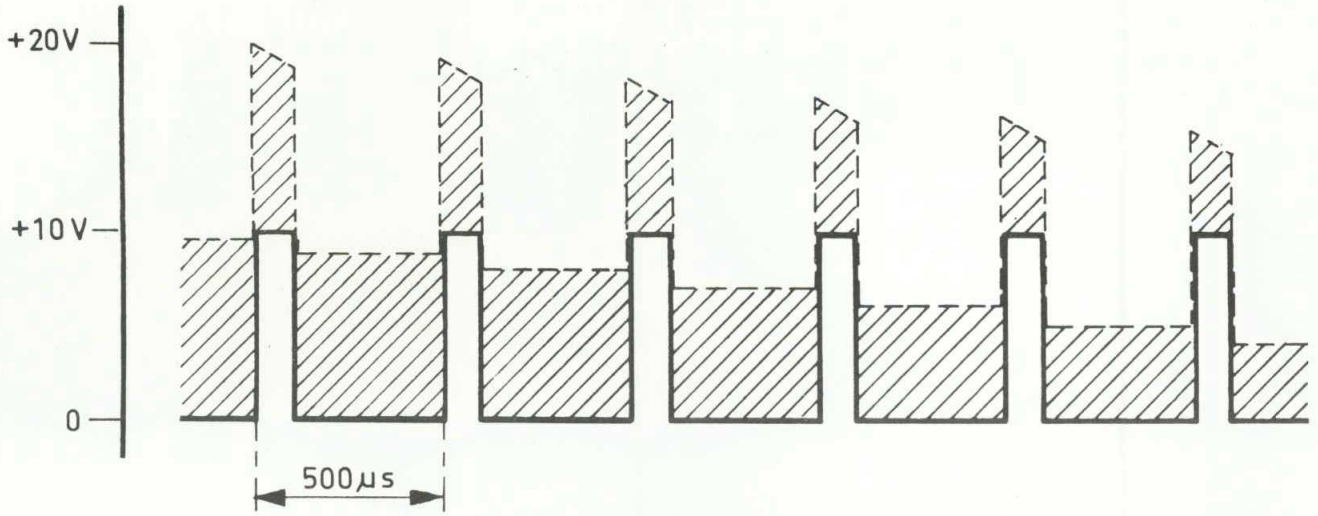
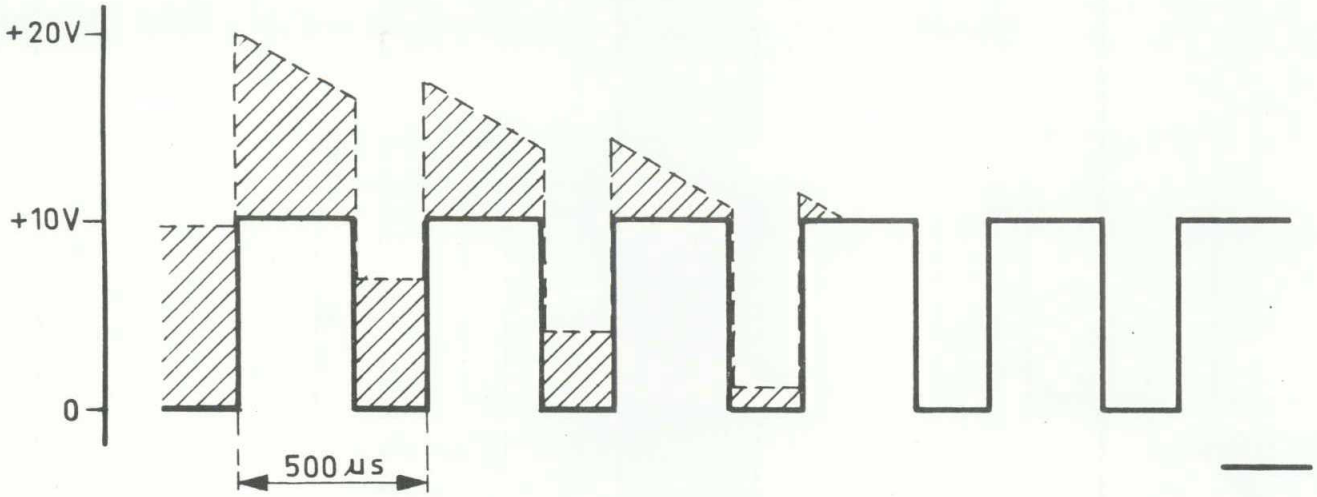
FLOOD GUN ACCELERATORS PULSE IN 'STORE' MODE

Fig. 3

Fig. 4



SMALL PULSE WIDTH
(LONG PERSISTENCE SETTING)



LARGE PULSE WIDTH
(SHORT PERSISTENCE SETTING)

——— STORAGE MESH POTENTIAL
- - - - LOCAL STORAGE LAYER POTENTIAL

POTENTIAL WITH RESPECT TO FLOOD GUN CATHODES

VARIABLE PERSISTENCE PULSES

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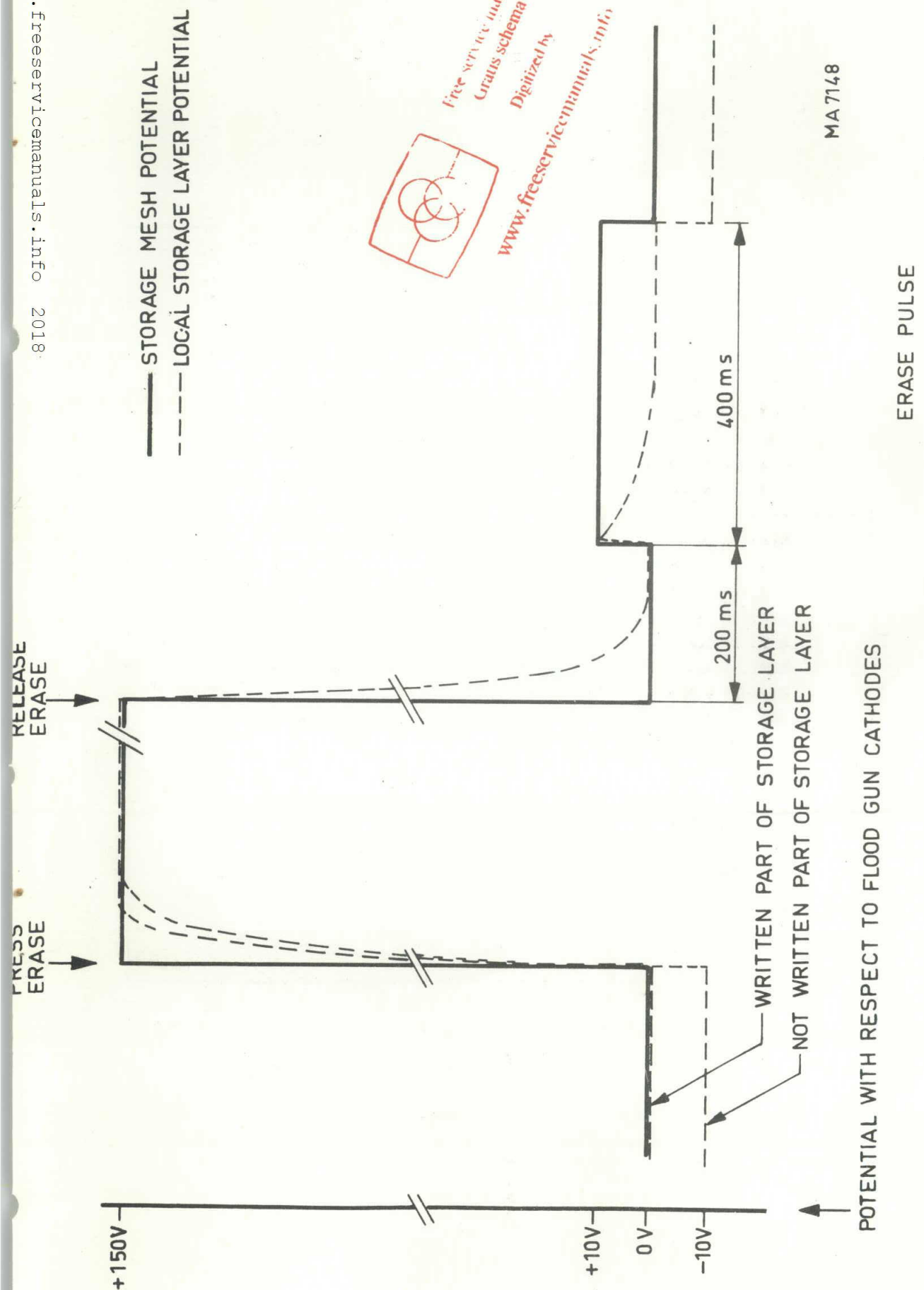

Fig. 5

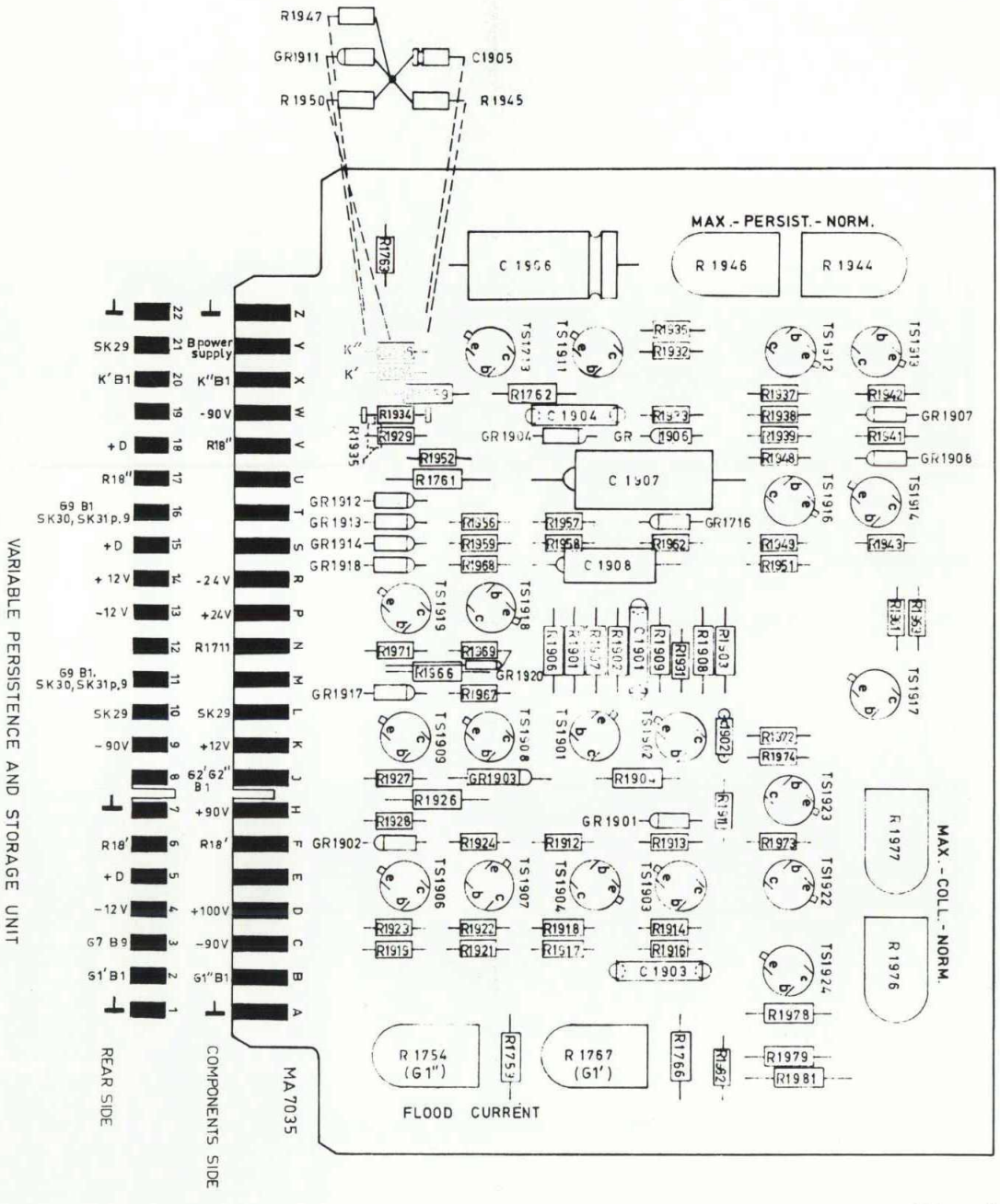

Fig. 6

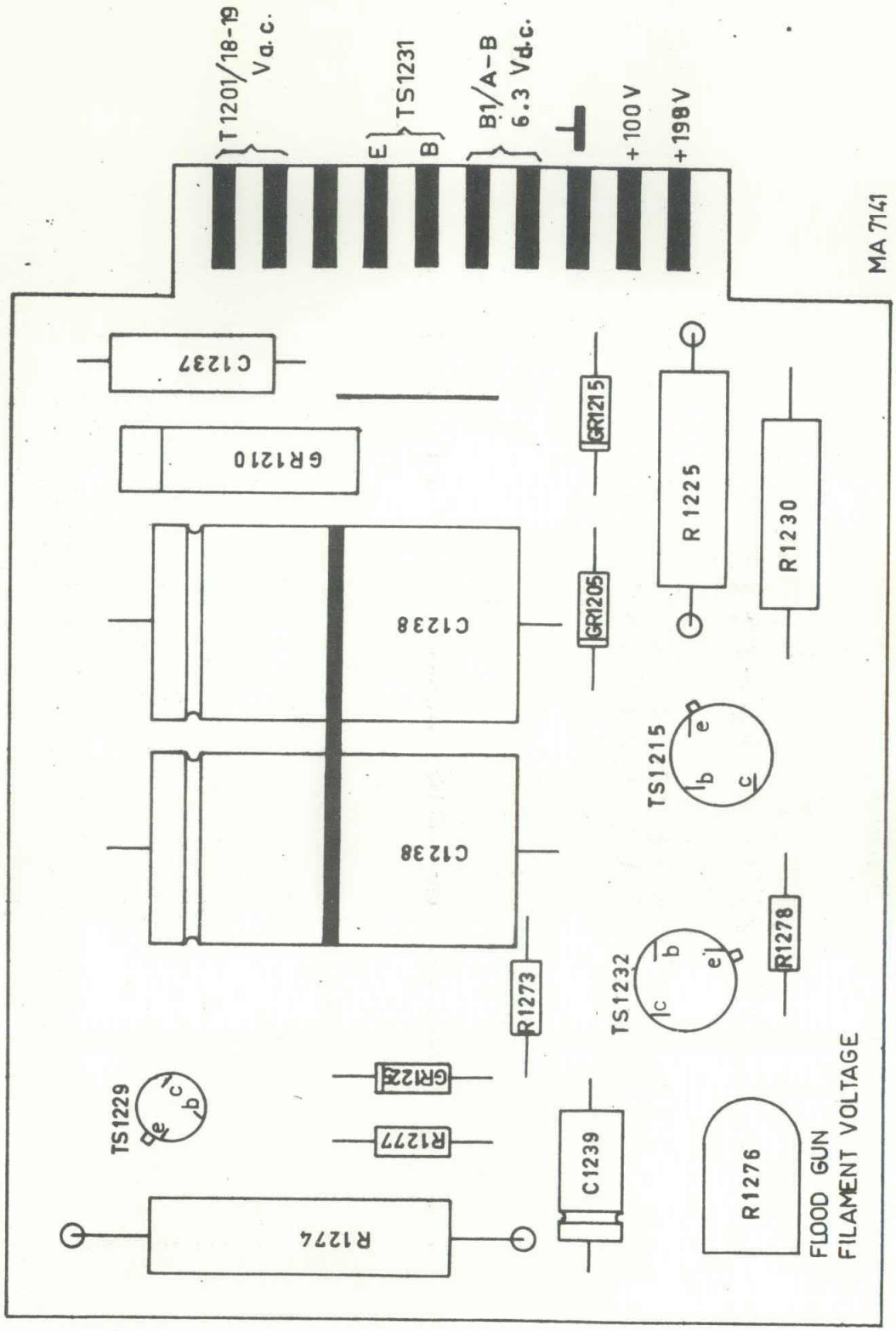

Fig. 7

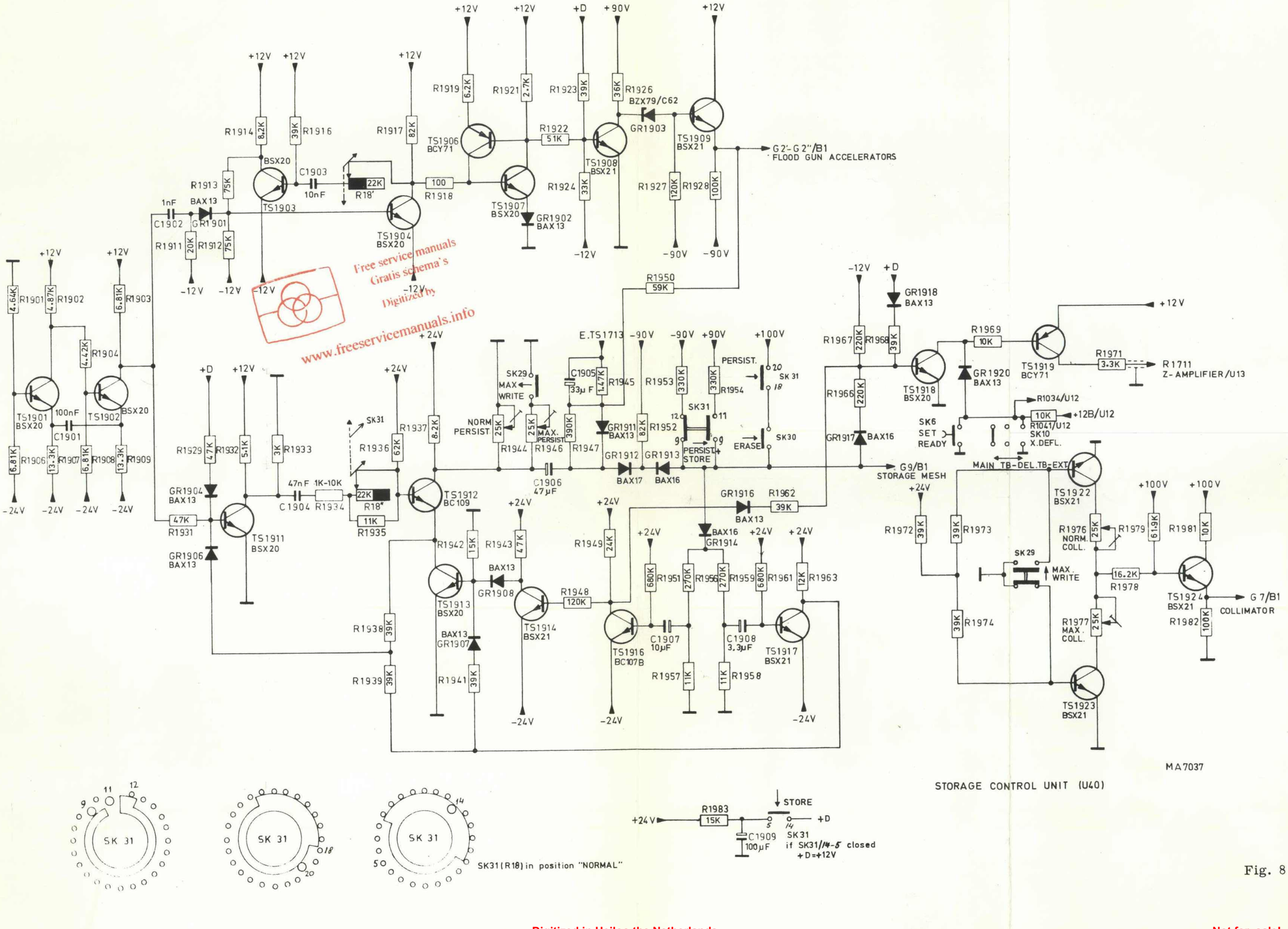

Fig. 8

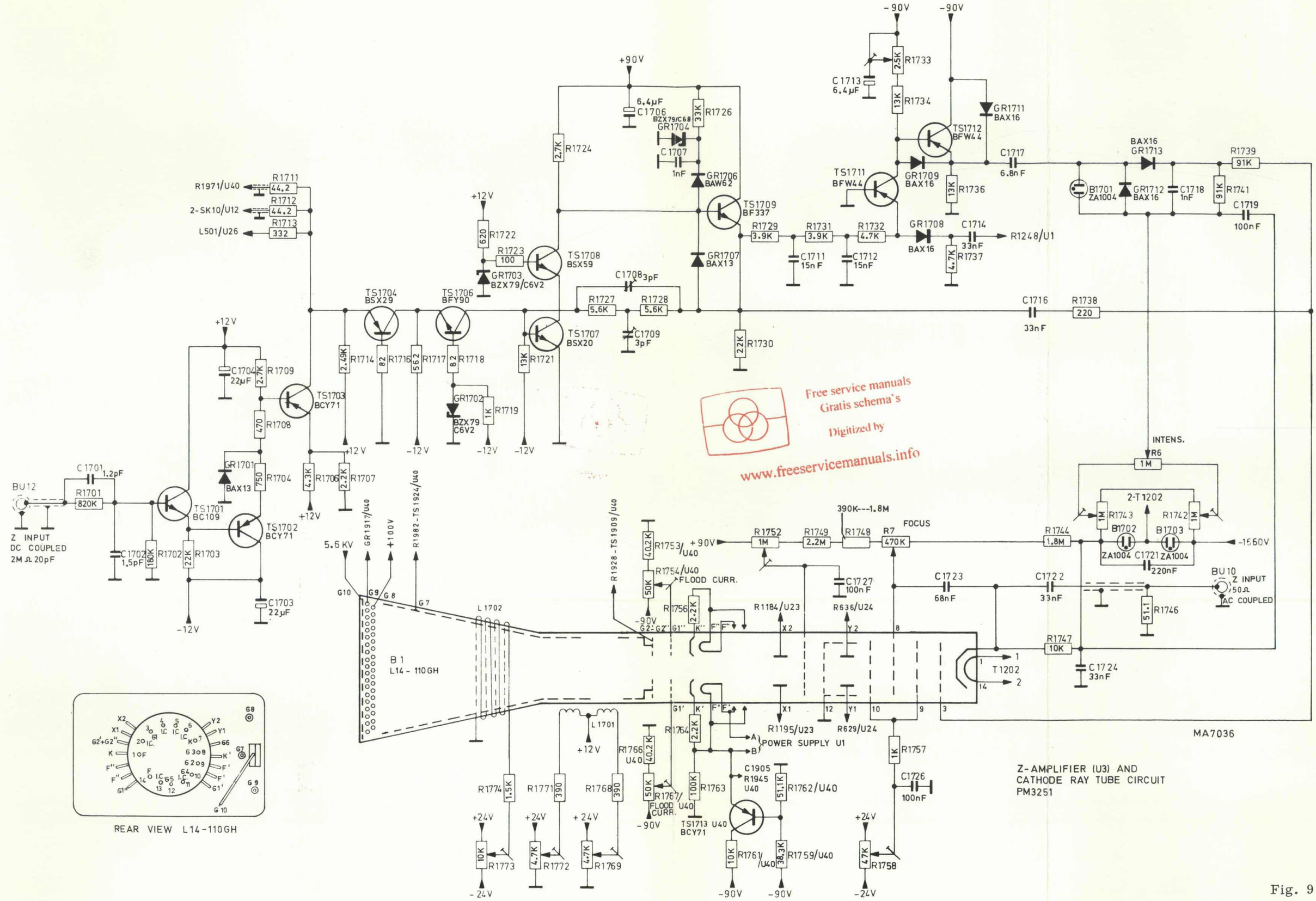

Fig. 9

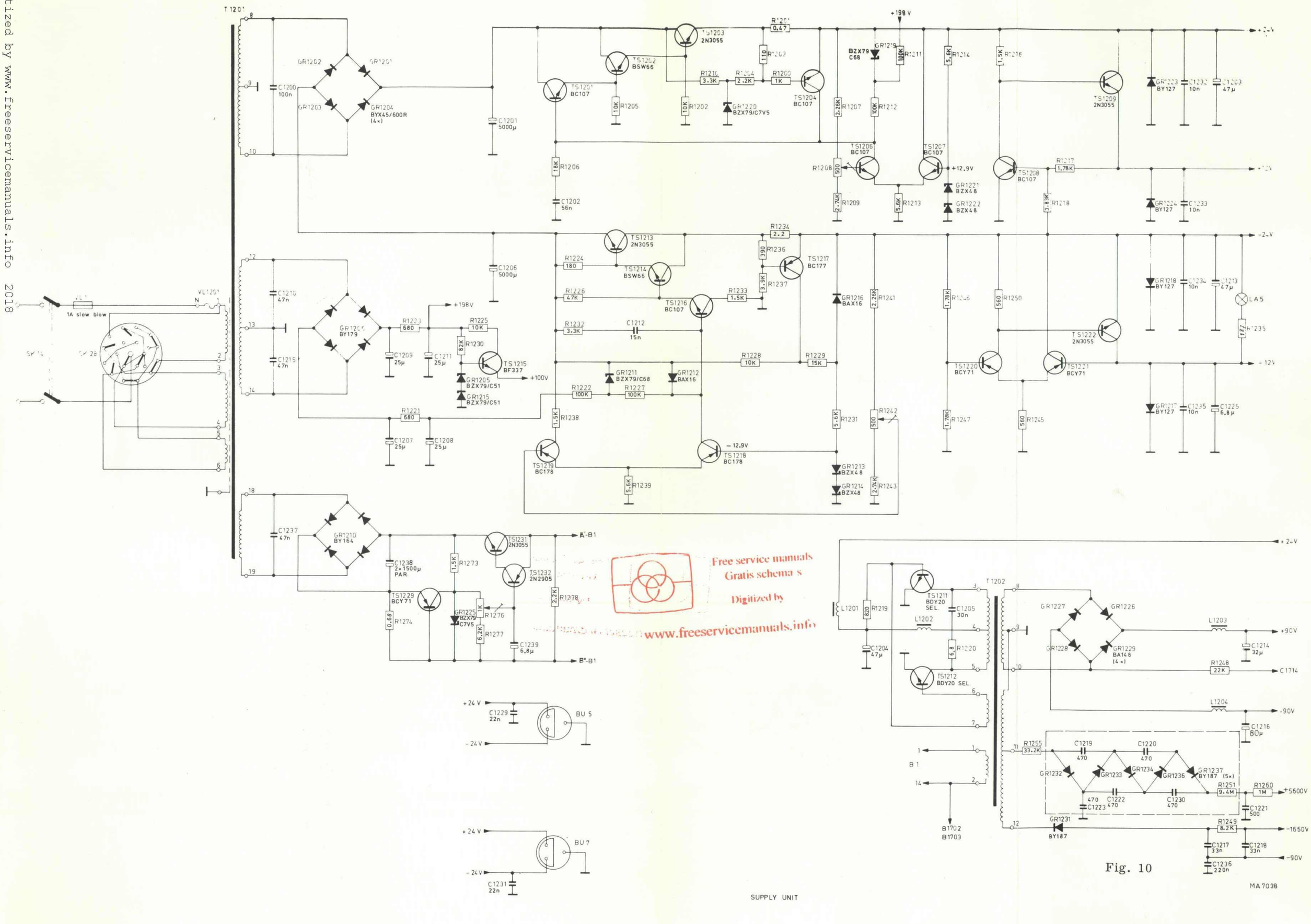

Fig. 10

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