05301-034

MAINTENANCE HANDBOOK FOR JTM DIMMER RACKS

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A DIVISION OF

RANK AUDIO VISUAL LIMITED

SCOPE

This handbook contains information normally required for maintenance and servicing of the equipment. Commissioning and operational information, where relevant, is covered in the associated User's Handbook.

SERVICE ASSISTANCE

For assistance with servicing or maintenance, please contact the nearest Regional Office, Agent or Associate Company (see list attached at the end of this handbook) and state the Order Reference, Equipment Reference or other relevant information as well as an indication of the fault-symptom encountered.

Revision/amendment since last issue of document:

◀ or ▶ on margin denotes minor changes.

◀ or ▶ against headings or illustration numbers denotes major revisions.

MAINTENANCE HANDBOOK

JTM 10/20-way DIMMER RACKS

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SUPPLEMENTS

PCB-034: Service Aid Information on Printed-Circuit Boards.

1-014: List of Regional Offices, Agents and Associate Companies.

ASSOCIATED PUBLICATIONS

05301-032: User's/Commissioning Handbood for JTM Dimmer Racks.

1. CIRCUIT DESCRIPTION

See Wiring diagram on page 13.

1.1. DIMMER MODULE

1.1.1. PRINCIPLE OF OPERATION

See Fig. 1.1.1.

Inverse-parallel connected thyristors SCR1 and SCR2 are supplied with firing pulses from the Trigger Unit such that each thyristor is switched on at the same relative instant during the appropriate conductive half-cycle of mains supply. The value of control-signal input to the Trigger Unit determines the firing instant; since each thyristor, once switched on, conducts till the end of the half-cycle, the control signal also determines the conduction phase-angles of the SCRs and hence the averaged a-c output to the load. With zero control-signal input, the SCRs are triggered 'on' at or near the termination of their half-cycles supplies, giving zero or a required minimum a-c output to load; with maximum control-signal (negative d-c or half-wave rectified a-c), the SCRs are triggered 'on' near the start of respective half-cycles, giving maximum a-c output to load.

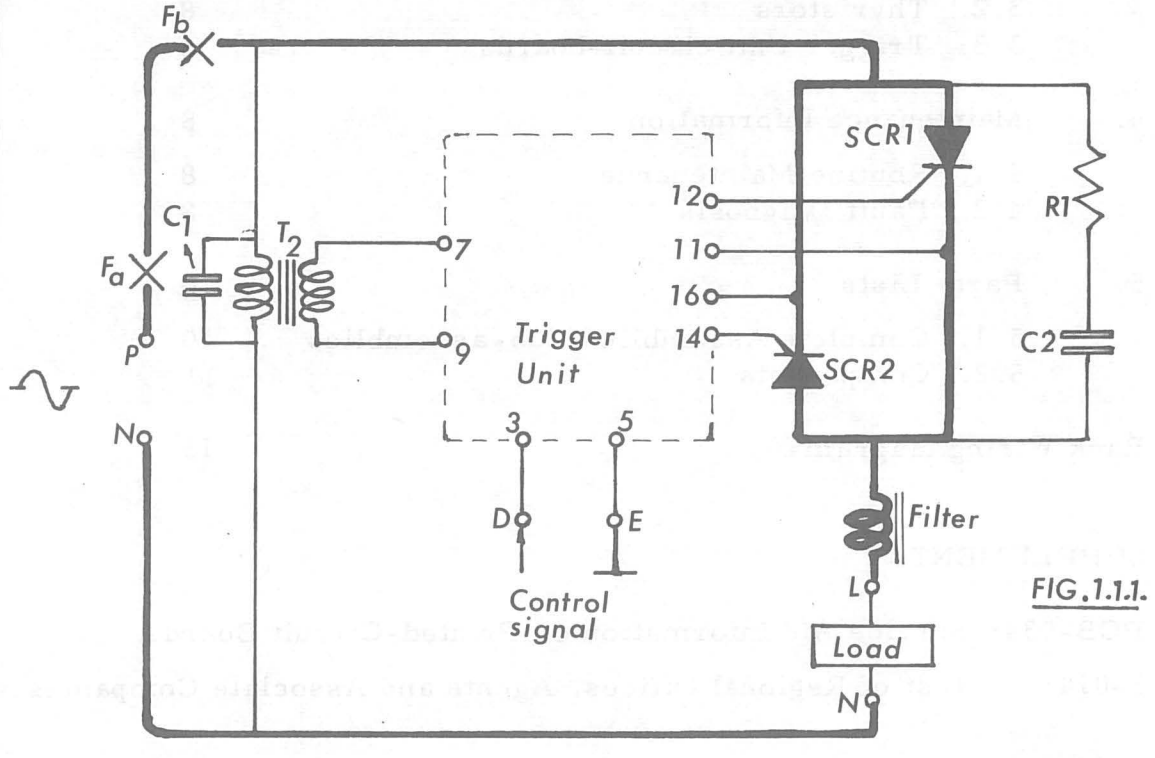


FIG.1.1.1.

⊥ : Common-Line

Fa: Fuse on 200-250V Modules;
Circuit-breaker on 110-120V Modules.

Fb: Fuse on 110-120V Modules

C2: 0.1uF 300V a-c)
R1: 100Ω 5W) on installations with poor mains-impedance

1.1.2. CIRCUIT DETAILS

Transformer T2 supplies 14V a-c to terminals 7 and 9 of the Trigger Unit. The control-signal input to Trigger Unit is applied via terminal D of the Dimmer Module, to terminal 3 of Trigger Unit, relative to terminal E of Dimmer Module and terminal 5 of Trigger Unit. This signal may be 24V a-c half-wave-rectified or a d-c signal, applied via a 10K ohms resistor.

Firing pulses to the SCRs are applied via terminal-pairs 11/12 and 14/16 of Trigger Unit.

The inductive Filter Unit serves to extend the rise-time of load output when the SCRs are switched 'on', and also to filter any switch-on transients, thus giving an output waveform suitable for interference-free operation of the lamps.

NOTE: As shown in the Wiring Diagram on page 13, terminals E of all Modules were connected to the mains-earth stud (on Rack framework) in the earlier Racks. In present Racks, terminals E of all Modules and terminal C of the 'Control' terminal block are connected to an insulated 'Common-line' stud, and a link is provided between terminals C and E on the 'Control' terminal block. This link is removed when the control application requires isolation of common-line from the mains-earth.

1.2. TRIGGER UNIT: Ref: 932/14 or 934 (see para. 5.1.2)

NOTE: Ref. 932/14 Unit is designed for wired-in mounting and Ref. 934 Unit is designed for plug-in mounting on the Dimmer Module.

1.2.1. SUMMARY

An exponential saw-tooth wave-form, with a repetition rate of one per half-cycle of the mains-supply, is generated and compared with the input control-signal, to switch 'on' a pulse-generator at the appropriate instant during each half-cycle; the 'ramp' wave-form and the pulse-generator are re-set at the termination of each half-cycle of mains-supply.

1.2.2. CIRCUIT DETAILS

See Fig. 1.2.2.1. for the circuit diagram;
See Fig. 1.2.2.2. for nominal waveforms.

NOTE: In the following description, unless otherwise stated, all voltages (and wave-form details) are nominal values and are referred to the common-line terminal 5.

Bridge-connected MR1 rectifies the 14V a-c supply fed to terminals 7 and 9 (waveform 1) to give a series of negative-half-cycle output (waveform 2) at R1-MR2 junction. MR2 isolates C6 from the 'positive' peaks of the above output and allows C6 to be charged negative to about -16V. R9 and MR4

provide stabilised -12V supply, by-passed by C3, to terminal 1 and the circuits of VT2-to-VT5.

VT1 is switched off for a 500uS period coincident with the 'positive' peaks of MR1 output (i.e. coincident with the zero-crossover instants of a a-c mains-supply), and is switched on for the rest of each half-cycle. With VT1 off, VT2 is switched on, discharging C2 and switching VT4 on; this in turn switches VT5 on and VT6 off. With VT1 on, VT2 is switched off; since C2 had been previously discharged, VT4 remains on, and capacitor C2 is charged negative via R5 and the base-emitter junction of VT4 (wave-form 4).

The input control-signal to terminal 3 is smoothed by C4, potential-divided by R8-VR2 and applied to VT3 base. VR1 provides gain-controlling feedback to d-c amplifier VT3. For given settings of VR1 and VR2, the value of control-signal input determines the collector-current of VT3 and hence the potential, due to this current alone, at VT3 collector and VT4 emitter. C2 has to charge to approximately this potential before VT4 is switched off, in turn switching VT5 off, and switching on the blocking oscillator circuit of VT6 to generate a 100uS pulse-train (waveform 5) which is fed, via the secondaries of T1, to the associated thyristors.

Thus, with zero signal input to terminal 3, the low collector current of VT3 requires C2 to charge to a higher voltage to switch VT4 off; hence 'firing' occurs near the end of each half-cycle. With a negative signal input, the higher collector current of VT3 requires C2 to charge to a lower voltage to switch VT4 off; hence the 'firing' instant is time-advanced in each half-cycle.

When VT6 is switched off coincident with the zero crossover instants of mains-supply, the pulses stop. Diode MR6 limits the back-emf in T1 primary to a safe value when VT6 is switched off.

1.2.3. BOTTOM AND TOP SET ADJUSTMENTS

VR1 (BOTTOM SET) is normally set to ensure that, with zero input, VT4 does not turn off till near the end of each half-cycle; VR2 (TOP SET) is set with maximum (negative) signal input, to give maximum output from the associated thyristors.

2. CHECK AND TEST PROCEDURE:

> NOTE: Use a voltmeter with sensitivity of not less than 10K ohm/V for all voltage measurements other than load output voltages; see NOTE in para. 4 below; see para. 4.1 of User's Handbook for output measurements.

A double-beam oscilloscope is advisable for waveform-checks since this enables comparison with mains-supply waveform.

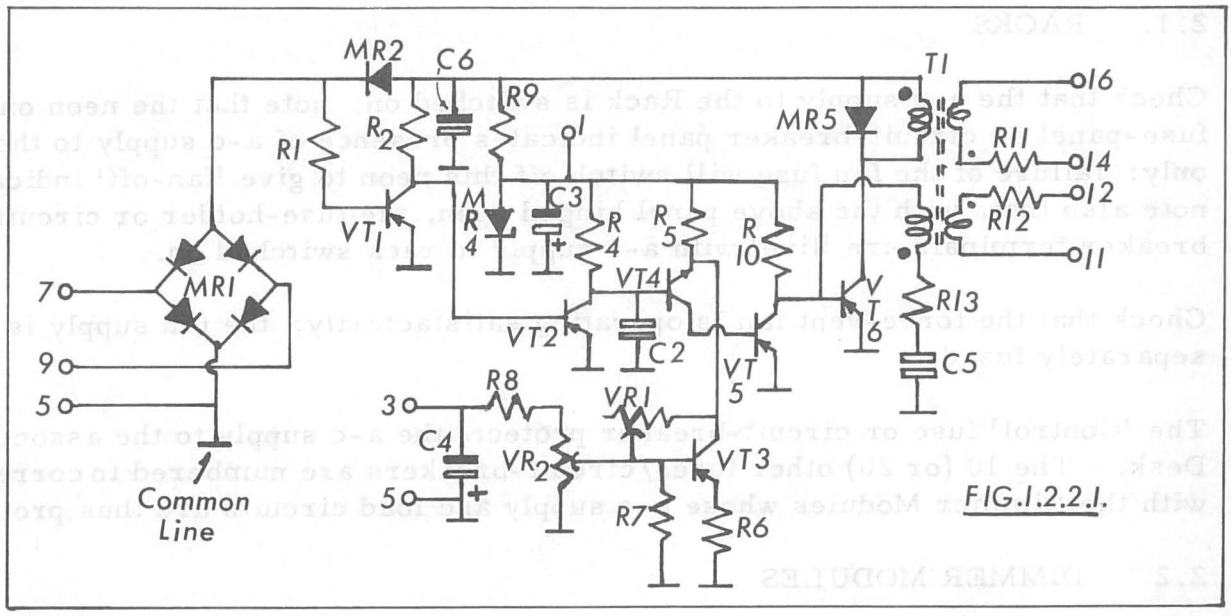


FIG.1.2.2.1.

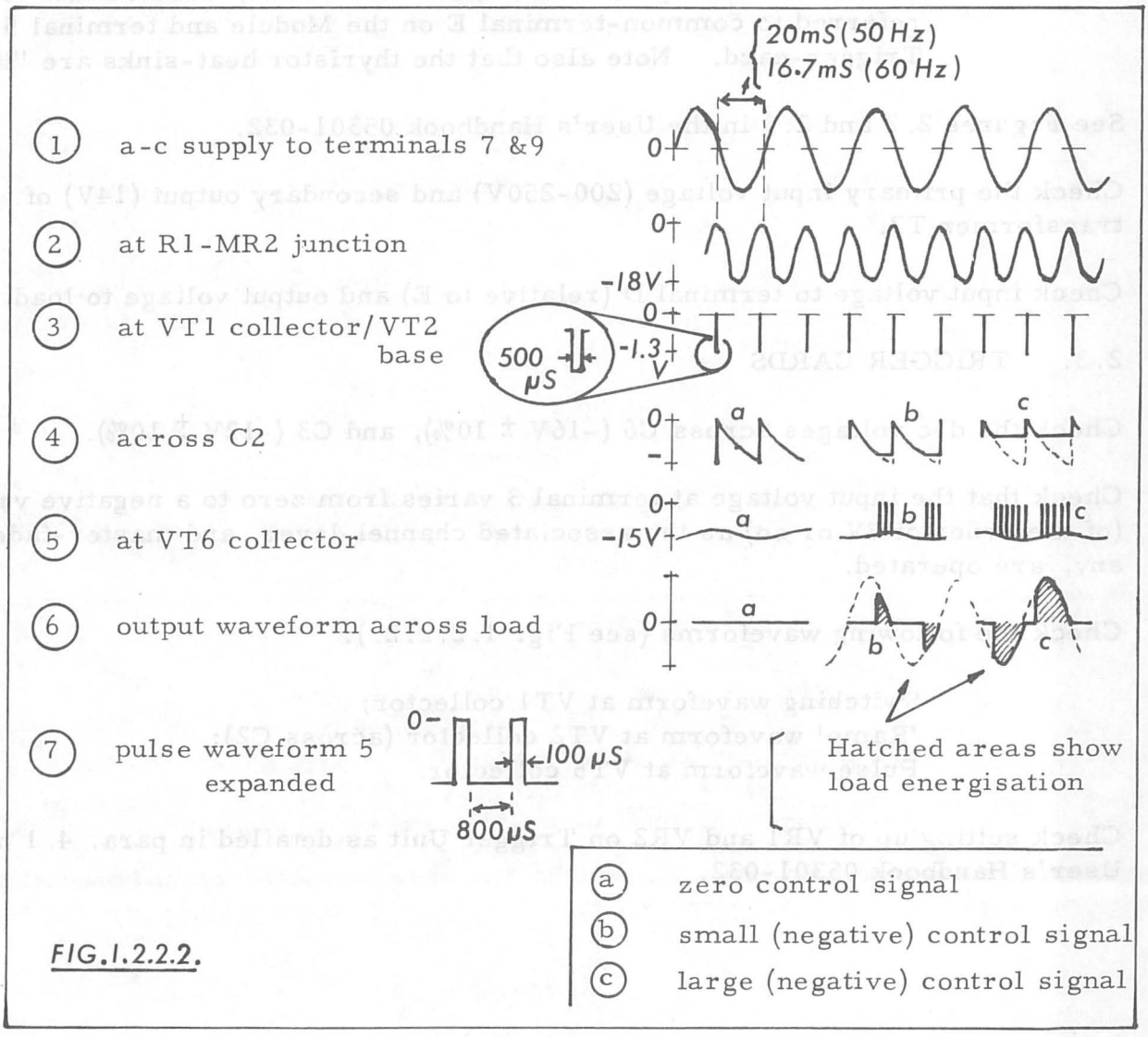


FIG.1.2.2.

2.1. RACKS

Check that the a-c supply to the Rack is switched on; note that the neon on the fuse-panel or circuit-breaker panel indicates presence of a-c supply to the fan only; failure of the fan fuse will switch off this neon to give 'fan-off' indication; note also that, with the above panel hinged open, the fuse-holder or circuit-breaker terminals are 'live' with a-c supply to rack switched on.

Check that the force-vent fan is operating satisfactorily; the fan supply is separately fused.

The 'Control' fuse or circuit-breaker protects the a-c supply to the associated Desk. The 10 (or 20) other fuses/circuit-breakers are numbered to correspond with the Dimmer Modules whose a-c supply and load circuits are thus protected.

2.2. DIMMER MODULES

> NOTE: All voltages, unless otherwise stated, are nominal values referred to common-terminal E on the Module and terminal 5 on Trigger-card. Note also that the thyristor heat-sinks are "live".

See Figures 2.2 and 2.3 in the User's Handbook 05301-032.

Check the primary input voltage (200-250V) and secondary output (14V) of transformer T2.

Check input voltage to terminal D (relative to E) and output voltage to load.

2.3. TRIGGER CARDS

Check the d-c voltages across C6 (-16V $\pm$ 10%), and C3 (-12V $\pm$ 10%).

Check that the input voltage at terminal 3 varies from zero to a negative value (of the order of 7V or so) as the associated channel-lever, and master-fader if any, are operated.

Check the following waveforms (see Fig. 1.2.2.2.):

> Switching waveform at VT1 collector;
> 'Ramp' waveform at VT2 collector (across C2);
> Pulse waveform at VT5 collector.

Check setting up of VR1 and VR2 on Trigger Unit as detailed in para. 4.1 of the User's Handbook 05301-032.

TABLE 3.2

Module		Thyristor			
Ref. No.	V & KW Rating	Make (Note 1)	Type No.	Tightening Torque	
				lb-in	Nm
JTM10 or JTM10C	240V, 1KW	W-H	CS22M/CF	30-35	3.37-3.93
		W-H	U1211/B5	42	4.72
		AEI	RS 1/5	30-35	3.37-3.93
		IRC	16RC60	20-25	2.24-2.8
JTM20 or JTM20C	240V, 2KW	W-H	CS21M/CF	30-35	3.37-3.93
		W-H	U1210/B5	42	4.72
		AEI	RS9/5	30-35	3.37-3.93
		IRC	30RCS60	25-30	2.8-3.37
JTM20L or JTM20LC	120V, 2KW	W-H	U1108/3	42	4.72
		AEI	CR30201A	85-100	9.64-11.23
		AEI	CR30203A	85-100	9.64-11.23
		AEI	CR30303A	85-100	9.64-11.23
		AEI	RS5/3	30-35	3.37-3.93
		AEI	RS9/3	30-35	3.37-3.93
		IRC	40RCS30	25-30	2.8-3.37
JTM30L or JTM30LC	120V, 3KW	W-H	U1108/3	42	4.72
		AEI	CR30201A	85-100	9.64-11.23
		AEI	CR30203A	85-100	9.64-11.23
		AEI	CR30303A	85-100	9.64-11.23
		AEI	RS5/3	30-35	3.37-3.93
		IRC	40RCS30	25-30	2.8-3.37
JTM50C	240V, 5KW	W-H	CS31MC/F	40-50	4.5-5.6
		W-H	U1108/5	42	4.72
		AEI	CR30403A	85-100	9.64-11.23
		AEI	CR30503A	85-100	9.64-11.23
		AEI	RS3/6	85	9.64
		IRC	40RCS60	25-30	2.8-3.37
JTM60L	120V, 6KW	W-H	42T3	84*	94.3
		W-H	U1109/3	126	141
		AEI	RS7/4	85-100	9.64-11.23
		IRC	71RA30	120-160	134-180

Note 1 : W-H = Westinghouse
AEI = AEI Semi-conductors
IRC = International Rectifier

* : on each base-mounting bolt

3. DISMANTLING/REPLACEMENT INFORMATION

3.1. DIMMER MODULES

In early versions of Dimmer Racks, the Modules were secured to the rack by four screws through the base-plate. In the present Racks, the Modules are secured by nuts on to studs provided in the Rack.

3.2. THYRISTORS

Do not attempt to remove the heat-sinks from the module base-plate; unsolder or disconnect the thyristor gate and cathode connections, and remove the thyristor from its heat-sink.

When replacing a thyristor: (a) use a replacement of the same type as the one removed from the module; note that alternative types listed for certain modules in the table below are not direct replacements but are electrical alternatives only, especially when the manufacturers differ; (b) ensure that the correct tightening torque is applied on the nut or nuts securing the thyristor to its heat-sink (see Table 3.2. on Page 7).

3.3. TRIGGER UNIT - PRINTED-CIRCUIT BOARDS

Where these are wired-in, they are secured to the top of the thyristor heat-sinks by four nylon studs.

4. MAINTENANCE INFORMATION

NOTE: Only a qualified electrician familiar with the equipment should undertake replacement or other maintenance work in the racks.

Always switch off the rack-supply isolator before undertaking any maintenance work on its interior. Remember that high voltages are present at thyristor heat-sinks and associated wiring, and take suitable precautions when testing or measuring with the supply switched on.

4.1. ROUTINE MAINTENANCE

The racks themselves require little routine maintenance apart from some attention to the fan (see paragraph 4.1.1. below) and periodical inspection of associated wiring and connections and, in very dust-prone environments, inspection of the rack-interior for any accumulation of dust; use a soft brush and suction-type low-pressure air-cleaner to effect the necessary cleaning.

4.1.1. FANS

The fan manufacturers advise that MK 3B and MK 4B - 6" - 1400 rpm fans have sealed lubrication for the bearings and this is normally adequate for 10,000 hrs. operating time; contact the Maintenance Department of Rank Strand Electric Limited for bearing replacement at the end of this period.

4.2. FAULT DIAGNOSIS

4.2.1. RACKS

Failure of a-c supply to associated Desk: Check 'Control' fuse or circuit-breaker.

Failure of force-vent fan and the neon indicator: Check the fuse above the 'Fan' label.

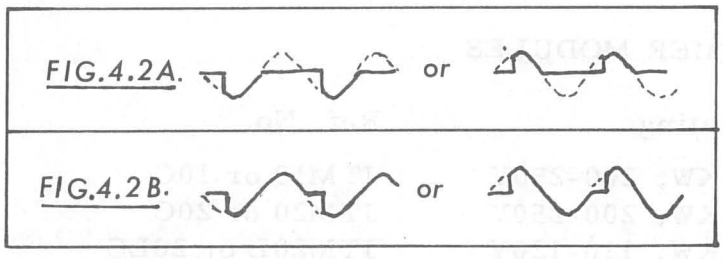
Complete failure of output to load and of a-c supply to the associated Module: Check the numbered fuse.

Failure of output to load only: Replace the Dimmer module as a complete unit and set up VR1 and VR2 as in para. 4.1 of the User's Handbook. If the module has a plug-in Trigger-card, replace this card first, to check if this is the faulty unit. For detailed servicing, where it is convenient to do so, the procedure given in para. 4.2.1.2. may be helpful.

4.2.1.1. Check presence of 'firing' pulses at VT 6 collector on the Trigger-card (see Fig. 1.2.2.2.) with an oscilloscope; if this is satisfactory, check the load and thyristor circuits - see below; if the pulse-check is not satisfactory, replace the trigger-card unit or check it in detail as in para 2.3.

4.2.1.2. Insufficient output to load: Confirm, by means of the test above, that the Trigger-card is satisfactory. Check waveform of output voltage across load, comparing it with the mains-supply waveform if possible - see Fig. 1.2.2.2.

If alternate half-cycles of output are missing (see Fig. 4.2.A), this indicates failure of one thyristor; check a-c supply to anode, and continuity from cathode to load; replace thyristor if the above two sets are OK; see para 3.2.



If alternate half-cycles of output waveform are complete half-cycles (see Fig. 4.2.B), this indicates a short-circuit across (or between) the anode and cathode of the respective thyristor; replace the thyristor.

4.2.2. TRIGGER-CARD UNITS

Specially where these units are plug-in items and also on wired in items, the following check may help to isolate a faulty unit:

Check 14V a-c supply to terminals 7 and 9.

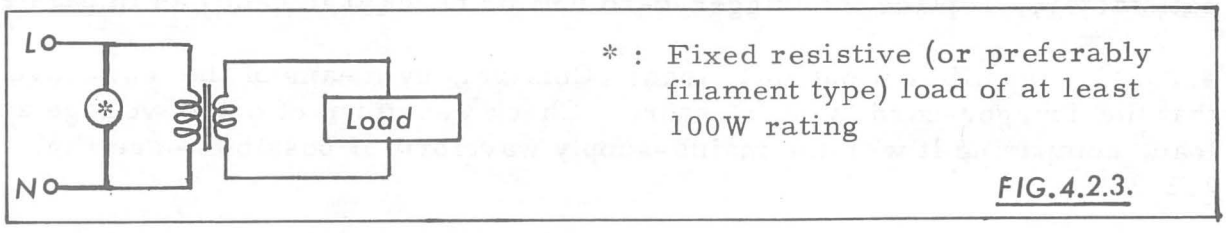
Check that the control voltage at terminal 3 can be varied from zero (or other minimum value) to -15V (or other maximum value, as set-up on site); if these tests are satisfactory, check presence of "firing" pulses at VT5 collector (the transistor-case) and that the timing of these pulses is controlled by the input voltage as shown in Fig. 1.2.2.2. If this test is not satisfactory, replace the Trigger card and set VR1 and VR2 as in para. 4.1. of the User's Handbook.

4.2 2.1. DETAILED TESTS ON TRIGGER CARD

See para. 2.3.

4.2 3. TRANSFORMER-FED LOADS

Figure 4.2.3. illustrates the typical external connection to L and N terminals of a Dimmer Module when used, for example, with a step-down transformer and a low-voltage lamp. Open-circuit of the fixed load across the transformer primary in such applications may result in overheating of, and damage to, the transformer if simultaneously the secondary load or circuit also becomes open-circuit; this is due to half-waving and the resultant large d-c component of currents in the transformer.



* : Fixed resistive (or preferably filament type) load of at least 100W rating

FIG.4.2.3.

5. PARTS LIST INFORMATION

5.1 COMPLETE ASSEMBLIES AND SUB-ASSEMBLIES

5.1.1. DIMMER MODULES

Rating	Ref. No.
1KW, 200-250V	JTM10 or 10C
2KW, 200-250V	JTM20 or 20C
2KW, 110-120V	JTM20L or 20LC
3KW, 110-120V	JTM30L or 30LC
5KW, 200-250V	JTM50C
6KW, 110-120V	JTM60L with filter separate.

5.1.2. TRIGGER-UNIT PRINTED-CIRCUIT ASSEMBLY

Plug-in type:	Ref. No. 934 or 934/2
Wired-in type:	Ref. No. 932/14 or 932/2

5.2. COMPONENTS

5.2.1. RACK COMPONENTS

Fan:	240V 50Hz :	MK3B Plannette, 6", 1400 rpm, with cowl
	or	
	110V 60Hz :	MK4B Plannette, 6", 1400 rpm, with cowl.
Neon Indicators	220V :	Thorn SGF 16/220 Yellow
	or	
	110V :	Thorn SGF 16/110 Yellow
Fan Fuse:	Belling-Lee L1055, 5A	
'Control' Fuse:	Reyrolle F190 (on 200-240V racks); or Circuit-breaker, Heinemann* 10A (on 110-120V racks).	
Dimmer/Load protection:	JTM10 or 10C: Fuse, Reyrolle F190, No. LA5. JTM20 or 20C: Fuse, Reyrolle F562, No. LC10. JTM20L or 20LC: Circuit-breaker, Heinemann* JTM30L or 30LC: Circuit-breaker, Heinemann* JTM50C: Fuse, Reyrolle F564, No. LD20. JTM60L: Circuit-breaker, Heinemann*	

5.2.2. DIMMER MODULE COMPONENTS

(Trigger Unit:	see para. 5.1.2)	
Transformer T2:	TRX981 on 110-120V Modules; TRX976 on 200-250V Modules.	
Capacitor C1:	0.5uF 250V a-c, Hunts type L45/6, List No. T25511 - on 110-120V Modules; 0.1uF 300V a-c, Hunts AB112 - on 200-250V Modules	
Thyristors SCR1 and SCR2:	see para. 3.2	
Filter Units	On JTM10 & JTM20 Modules:	J2HV50
	On JTM10C Modules:	J1HV50C
	On JTM20C Modules:	J5HV50CX
	On JTM20L Modules:	J2LV60
	On JTM20LC & 30LC Modules:	J3LV60C
	On JTM30L Modules:	J3LV60
	On JTM50C Modules:	J5HV50CX
	For JTM60L Modules:	J6LV60 (laminated core); J6LV60C (C-core)

* : Series 0411

Fuses on Low-voltage Modules:	On JTM20L & 20LC Modules: English Electric, HRC, C25K-25A On JTM30L & 30LC Modules: English Electric, HRC, C30K-30A On JTM60L Modules: English Electric, HRC, C60K-60A

5.2.3. TRIGGER-CARD COMPONENTS

(see Fig. 1.2.2.1)

Circuit Reference	Description	Part or Ref. No.
C2	Capacitor, 0.1uF 250V,	Mullard C281AB/A100K
C3	25uf 25V,	Mullard C426AR/F25
C4	2.5uF 64V,	Mullard C426AR/H2.5
C5	0.33uF 250V	Mullard C281AB/A330K
C6	250uF 25V	Mullard C437AR/F250
MR1	Rectifier, Westinghouse, RA12022/2 Bridge	
MR2, MR5	Diode, Texas Instruments, 1S920	
MR4	Diode, Zener, Texas Instruments: 1S2120A; AEI: MR120-H	
► R1	Resistor, 1K 10% $\frac{1}{4}$W, Erie type 16 or Morganite Type S	
R2, R8	10K (as above)	
R4	100K (as above)	
R5	5.6K (as above)	
R6, R13	100 ohms (as above)	
R7	2.7K (as above)	
R9	330 ohms (as above)	
R10	3.9K (as above)	
R11, 12	10 ohms (as above)	
T1	Pulse transformer TRX770	
VR1, VR2	Potentiometer, 50K, Morganite 62H	
► VT1-to-VT3 & VT5)	Transistor, ME 0404/2 (Micro Electronics)	
► VT4	ME 6002 (Micro Electronics)	
► VT6	NKT 228/S1 Newmarket	

JTM DIMMER RACK WIRING DIAGRAM