

DESIGNS DEPARTMENT HANDBOOK NO.1.103(72)

Amplifier, Recording, Magnetic AM15/503P

C O N T E N T S

1. Summary
2. Description
  - 2.1 Mechanical
  - 2.2 Electrical
3. Maintenance
  - 3.1 D.C. Tests
  - 3.2 A.C. Tests

D R A W I N G S

Circuit Diagrams

Sub-Assembly No. 1	D 31506 A2
" " No. 2	D 31508 A2
" " No. 3	D 31510 A2
Main Circuit	D 31503 A2 (Interconnections)

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Amplifier, Recording, Magnetic AM15/503P

1. Summary

This equipment is a re-design of the AM15/502P designed in 1958 for film cameras using magnetic striped film. It consists of a two channel microphone (30-200 ohms impedance range) and a line input mixer, feeding a limiter which can be switched in and out of circuit. The limiter feeds the recording amplifier which is capable of feeding a 1-12mH range of recording heads and uses a 50kHz frequency bias current supplied by a local oscillator. The recording amplifier feeds a line amplifier which delivers a programme volume of about -20dB from a balanced output of about 220 ohms source impedance. There is also a replay amplifier which feeds a monitor amplifier for headphone use. Visual monitoring is provided by a standard BBC miniature PPM and associated amplifier, the meter also being used for indicating bias and battery volts. The power supply consists of eight U2 type of cell (12V). The equipment is contained in an aluminium alloy box measuring  $26\frac{1}{2} \times 8\frac{1}{2} \times 19\frac{1}{2}$ cms and weighs 3.25kg.

2. Description

2.1 Mechanical

The electronics are carried on 3 similar sized printed wiring boards 23 x 7 cms which are fitted with McMurdo type 701 29 way plugs, each plug being fixed to a bridge separated from the board by 3 1.4 cm spacers. These boards slide into spring loaded runners and the plugs on the boards mate with 29 way sockets carried on a fixed framework mounted on the main framework of an open sided box, the sides of which carry the spring loaded runners. The top of the box carries the meter and controls and under the controls is a photo-anodised stick-on label. This label material is also used on the top half of the two ends of the box indicating the microphone, line, camera plugs etc. This box is made of 18 SWG aluminium alloy, the front and back being open for access to the boards. The whole of the box slides into an outer case and there are detachable top and bottom covers. A carrying strap is fixed to the top of the box. The bottom of the box forms a compartment for two sets of 4 U2 type cells contained in rigid PVC tubes which the bottom cover holds in position. Before putting the box into the outer case two protective panels consisting of  $1/32$ " paxolin covered on one side with  $1/8$ " polyurethane foam sheet are placed on either side of the box openings. One of these panels should carry a legend of the pre-set controls used on the boards. Further information in the form of 4 circuit diagrams produced by a Dye-line process are stuck on either side of two aluminium plates and carried in a plastic folder; this folder is carried in the leather case.

2.2 Electrical

The electronics are carried on three printed wiring boards the top board (P.B.1) carries the components for the 2 channel mixer and the limiter circuit, the middle board (P.B.2) has the components for the recording amplifier, bias oscillator and the line amplifier and the bottom board (P.B.3) has the components for the replay, monitor and P.P.M. amplifiers.

The top board (P.B.1) carrying the 2 channel mixer and limiter uses Cannon 3 pin plugs mounted on the left hand side of the box for the microphone inputs, the impedance range being 30-200 ohms. The plugs are connected to the input transformers (LG59) for the normal 200 ohms microphone but if a 30 ohms microphone is to be used a tapping on the transformer has to be used (Tappings on LG59 - Green/Red for 200 ohms - White/Red for 30 ohms). Between the microphone plugs is the line input plug which is connected to the primary of the input transformer of Channel 2 via a 42dB attenuator and presents an impedance to line greater than 50K ohms. The mixer amplifier is a 2 stage unit with switched feedback giving normal gain; this gain can be reduced by 20dB and by 40dB. The controls on the top panel are marked "MIC 1 ATT 0 20 40 dB" and "MIC 2 ATT 0 20 40 dB". It is recommended that when the Line input is used the MIC 2 ATT be set at 20 or 40dB attenuator positions. Both channels are provided with Bass Cut controls on the top panel marked "MIC 1 B/C 0 6 15 dB" and "MIC 2 B/C 0 6 15 dB" which means that the nominal attenuation at 100Hz relative to 1kHz is 0, 6 and 15dB. These bass cut positions are provided by capacitors C7, C8 and C9 for Channel 1 and C21, C22 and C23 for Channel 2 in association with the mixer controls marked "MIC 1 GAIN" and "MIC 2 GAIN". There is therefore a certain amount of bass cut variation dependent on the position of these Gain controls but it is not serious and can be neglected. The signals from the GAIN controls are fed into the Limiter which can be switched in and out of circuit by the control on the top panel marked "LIM IN OUT". The Limiter consists of a two stage amplifier (transistors TR3 and TR4) which is in the normal signal chain of the recording amplifier and a limiter stage (transistor TR5) which converts this amplifier into a limiter when the feedback circuit is connected via the limiter IN/OUT switch. This board has no pre-set controls on it.

The middle board (P.B.2) consists of the recording amplifier, bias oscillator and a line amplifier. The recording amplifier has an input pre-set gain control which is fed from the limiter. It is a two stage amplifier with feedback between the stages and the feedback network has a pre-set high frequency control. The output stage is capable of feeding a recording head in the impedance range 1-12mH and employs the series type of circuit for bias addition. The 50kHz bias oscillator is of the tuned collector push-pull type and is supplied with power via a regulator which includes a pre-set control for varying the amount of bias current in the head from 0 to the required amount. From a parallel high impedance resistive circuit which includes a pre-set control across the recording head a bias feed is taken via a rectifier circuit to the PPM meter for bias indication. The signal feed from the limiter is also taken to the line amplifier which consists of a single emitter follower stage which introduces a loss, because about -20dB programme volume is required from an input of about 0dB p.v. The output impedance is about 200 ohms, approximately balanced and should feed into a fairly high impedance load. Precautions are taken in this amplifier to keep the bias frequency signal at a very low level from the output.

The bottom board (P.B.3) consists of the replay, monitor and PPM amplifiers. The replay amplifier is a 2 stage unit with an input transformer for use with an impedance range of replay heads of 1-12 mH. The interstage feedback network incorporates the inverse of the 100µS recording characteristic and a pre-set high frequency control. The output is fed via a pre-set gain control to the monitor and PPM selector switches. The monitor switch on the top panel selects the replay amplifier output or the input to the recording amplifier and it is marked "MONITOR REP REC". The PPM selector switch is marked "METER BATT BIAS REC REP" and indicates in the BATT position that the battery should be changed when the reading falls below 4 on the meter which corresponds to 9.0V; the bias

indication can be adjusted to read 4 on the meter by the pre-set control mentioned earlier when it has been set to its correct value of current in the head. The indications of Recording input and Replay output are for level monitoring purposes. The Monitor amplifier is a two stage unit with feedback, the output feeding the camera operators headphones directly via the 6 pin Cannon plug and the sound recorders headphones via a volume control (marked VOL) and phones socket. These components are mounted on the right hand side of the box together with the LINE OUT socket.

There is one other control on the top panel marked "OFF REP REC", and it must be used in conjunction with the phones jack. In the "OFF" position the equipment is switched off and it is also off if the phones plug is not inserted; this is a safety device for protection of battery life. The box is carried in a leather case but it will not fit into the case if the phones plug is in its socket. With the phones plugged into its socket and the switch turned to "REP" all the units are energised except the recording amplifier and bias oscillator so that a film may be replayed without being erased or an input signal to be recorded can be lined up for correct levels before turning the switch to "REC".

The PPM amplifier is a three stage unit feeding a voltage doubler rectifier and a BBC miniature meter. There are 2 pre-set controls for adjusting the LAW of the meter.

### 3. Maintenance

Designs Department Manufact. Inf. No.1.101(72) contains the Production Test Schedule of this equipment where detailed tests are given.

#### 3.1 D.C. Tests

Using an AVO Model 9 (Mk 2) on its 0-100mA or 0-1 Amp and 0-30V ranges a typical set of measurements are shown below:-

Supply Voltage	12V	9V	
Total Current	134mA	110mA	With Rec. Head Output S/C
PB1 Current	14mA	10mA	
PB2 Current	97mA	80mA	With Rec. Head Output S/C
PB3 Current	27mA	20mA	
Total Current less			
Rec. Amp. and Bias			
Osc.	45mA	32mA	

#### 3.2 A.C. Tests

##### 3.2.1 Impedances at 1kHz

Microphones 30 - 200 ohms  
Recording Heads 1 - 12mH  
Line Input Bridging  
Replay Heads 1 - 12mH  
Monitor Output Load  $\frac{1}{2}$  1.2K ohms  
Line Amplifier Output Load  $\frac{1}{2}$  5K ohms

##### 3.2.2 Gain 1kHz Limits $\pm$ 1dB

Apply a level of -66dB to MIC 2 or a level of -24dB to the Line Input.  
Set MIC 2 ATT at 20dB  
Level at MIC 2 GAIN at max. -34dB  
Level at Input to Limiter -44dB  
Level at Output of Limiter -6dB

Level at Input to Monitor	-38dB
Level at Output of Monitor (1.2K load)	-7dB
Level at Input to PPM	-38dB
PPM reads	4
Level at Input to Line Amplifier	-6dB
Level at Output of Line Amplifier (load 5.1K ohms)	-26dB

If a 6mH recording head is available connect it to the appropriate pins. Adjust the pre-set gain control of the recording amplifier to give an input level of -36dB which should give a recording current of 0.25mA, that is, a level of -50dB across the 10 ohms resistor R11. This test must be done with the bias control at minimum.

For a 12mH head the bias current required to record the correct level is about 10mA, but the oscillator should provide a maximum A.C. current of about 12mA.

The nominal gain of the replay amplifier is 38dB  $\pm$  1dB, with the gain control at maximum.

### 3.2.3 Frequency Response

The frequency response of the chain consisting of the pre-amplifiers (i.e. the mixer amplifiers) and of the limiter should be within  $\pm$  1dB limits over the frequency range 60Hz - 10kHz. If the Line Output Amplifier or the Monitor Amplifier or the PPM Amplifier is added to the above chain the frequency response should not be altered.

Adding the Recording Amplifier to the above chain will give a frequency response depending on the position of the HF control of the recording amplifier. For limits see Specification No. 1.101(72).

The frequency response of the replay amplifier depends on the position of its HF control and typical results are shown in Specification 1.101(72).

### 3.2.4 Non-Linearity

Non-linearity tests on the individual units are given in detail in Specification No.1.101 (72).

### 3.2.5 Noise

With MIC 1 input short-circuited and the gain controls of the Mixer Amplifier at maximum and also that of the Monitor Amplifier, the noise measured with an A.C. Voltmeter at the output of the Monitor Amplifier loaded with a 5.1K ohms resistor should be better than -48dB,

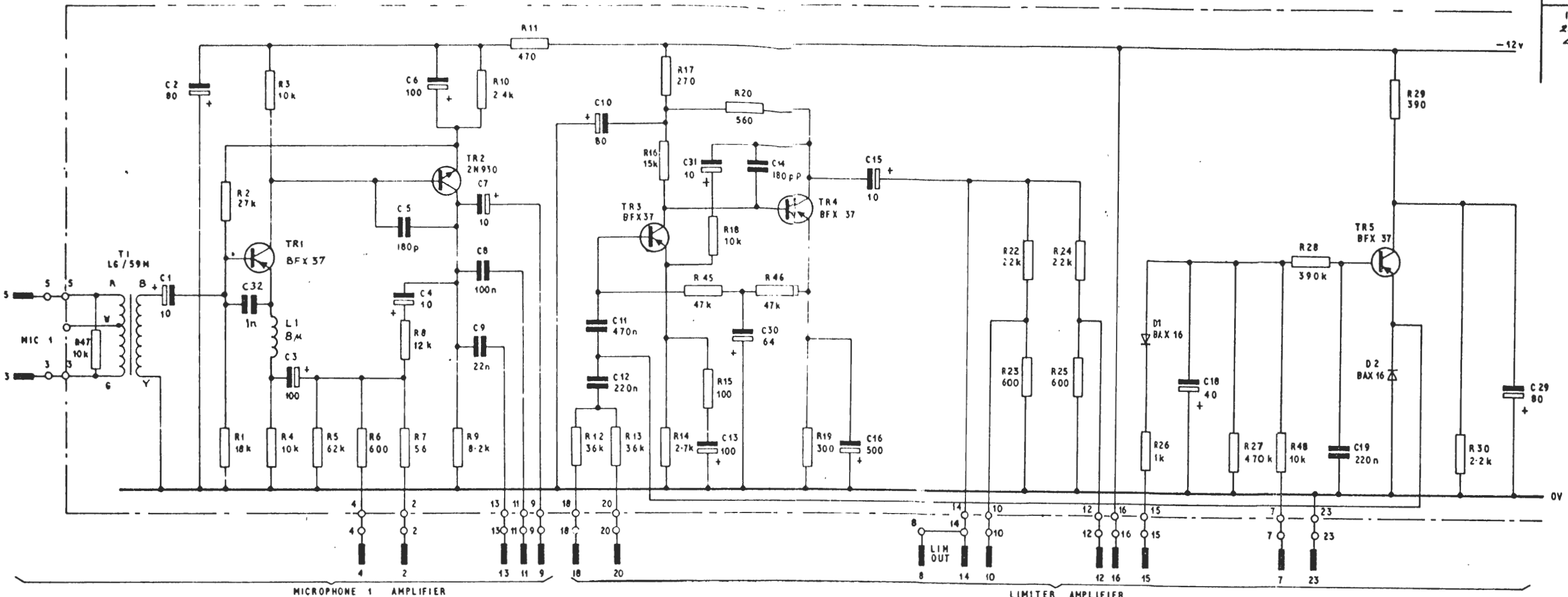
CHANGE	ISS
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22-11-72	2
4-1-73	3

D 3150 6A2

AM15/503P (SUB ASSEMBLY (10.1) CIRCUIT

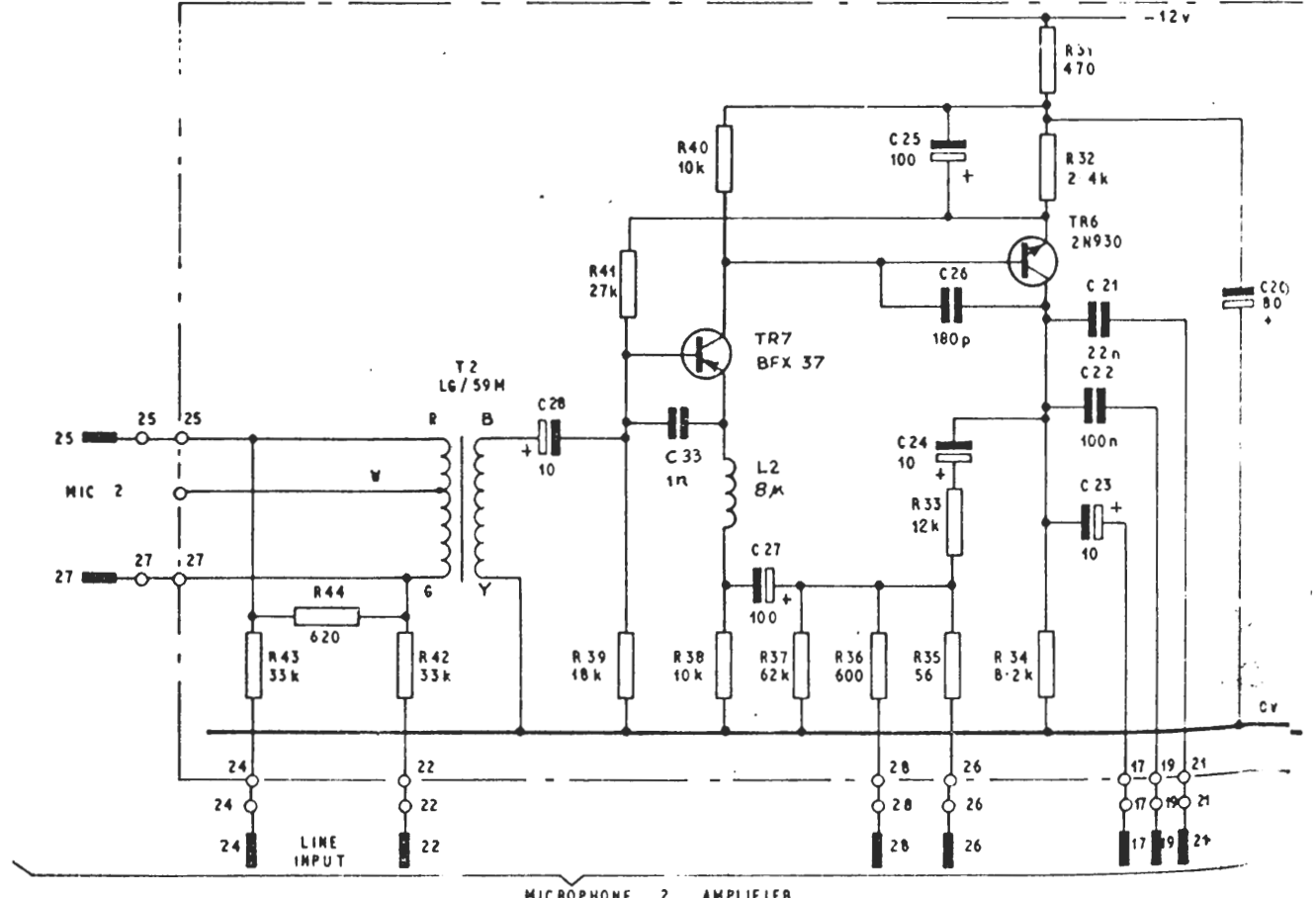
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BBC  
DS/A2



MICROPHONE 1 AMPLIFIER

LIMITER AMPLIFIER



MICROPHONE 2 AMPLIFIER

TRANSISTOR TERMINATIONS  
VIEW ON LEADS



BFX 37  
2N930

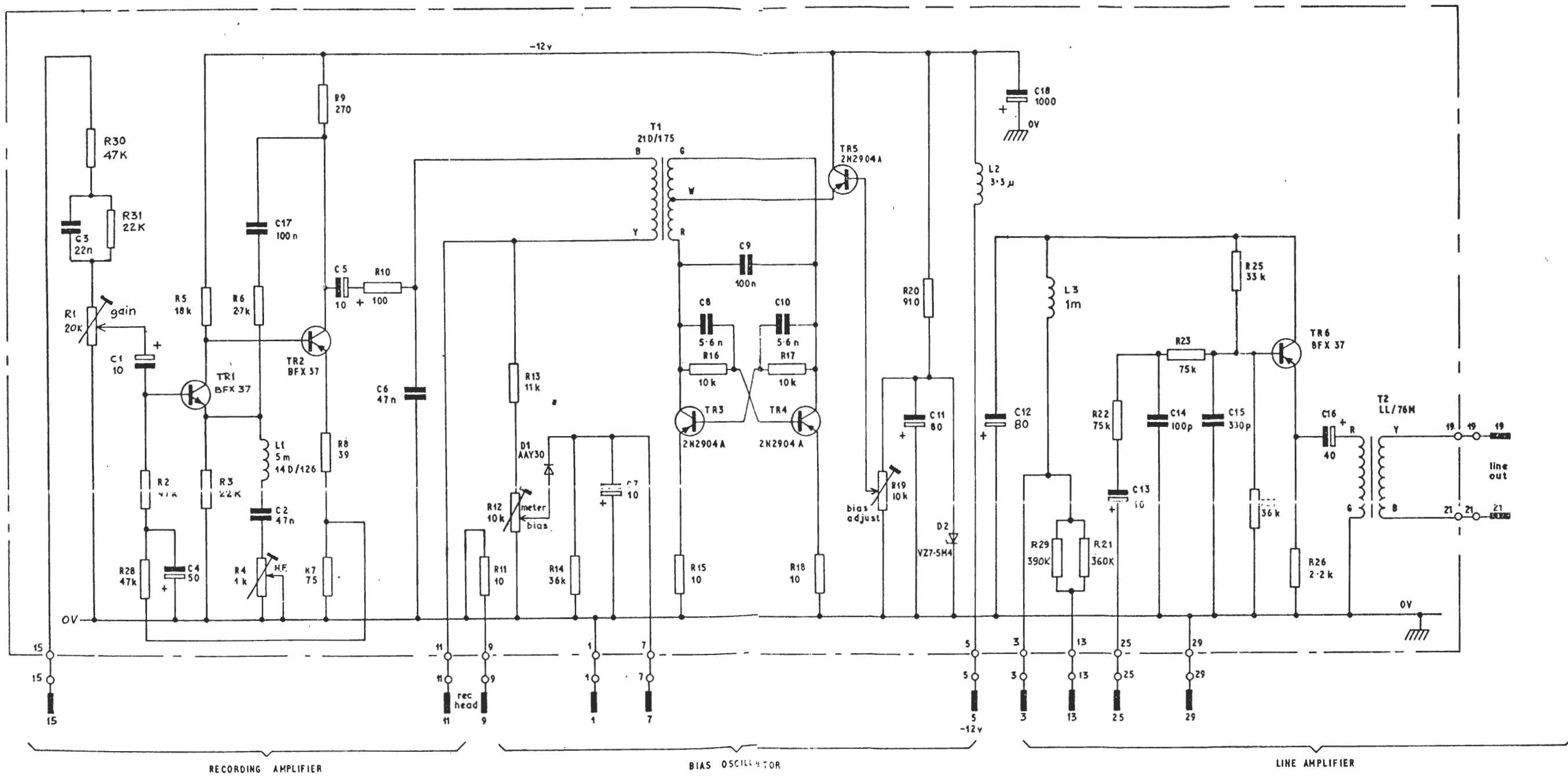
AM15/503P (SUB ASSEMBLY (10.1) CIRCUIT

PARTS LIST: D31504A4

DRN	Z M	DESIGNS DEPARTMENT
TCD	B. Y.	
CKD		
APPD	J.P.	<b>D31506A2</b>

D 31508A2

AM15/503P SUB ASSEMBLY No 2 CIRCUIT



RECORDING AMPLIFIER

BIAS OSCILLATOR

LINE AMPLIFIER

TRANSISTOR TERMINATIONS  
VIEW ON LEADS



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BBC  
D31A2

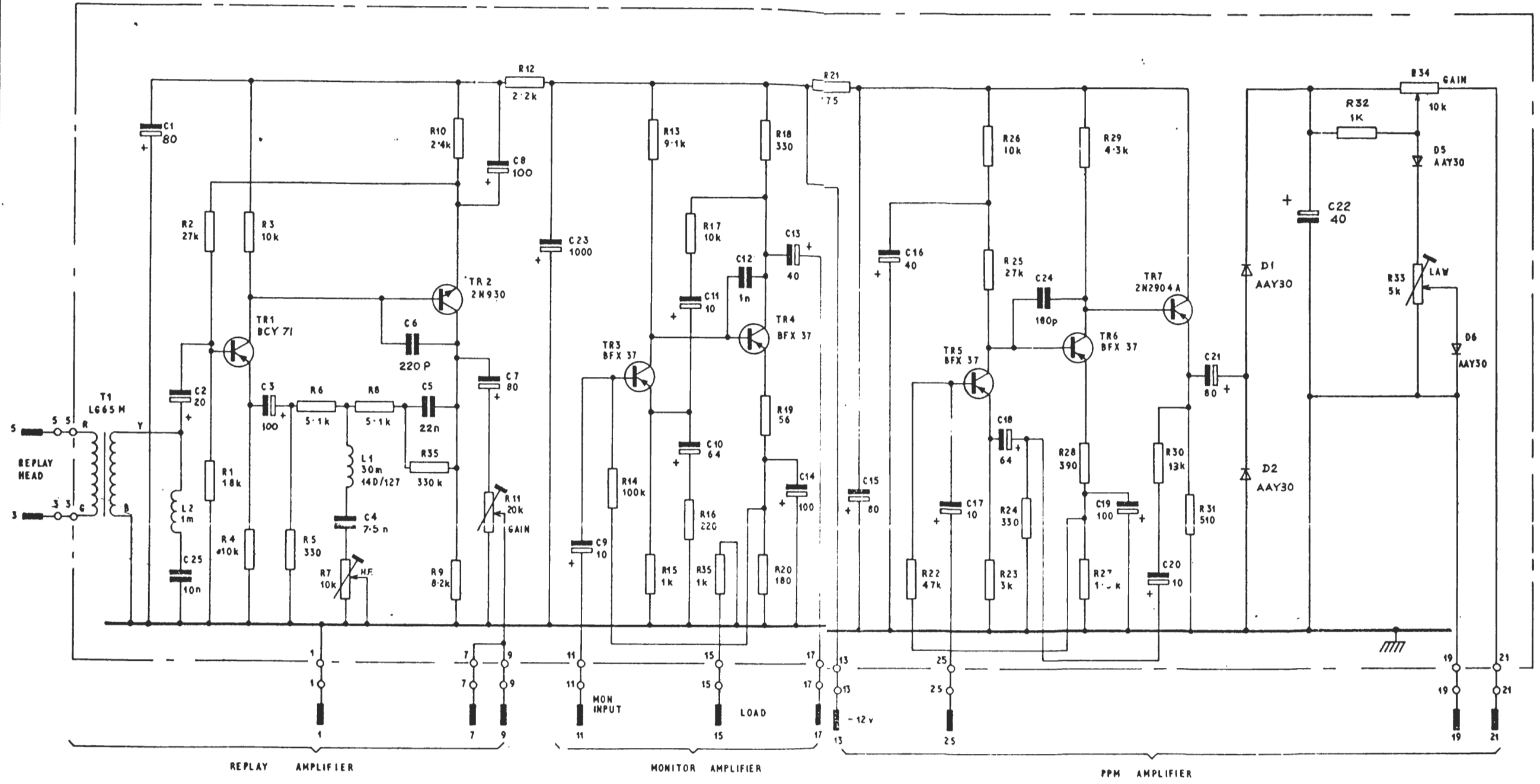
AM15/503P (SUB ASSEMBLY No 2) CIRCUIT

PARTS LIST D31504A4

DRN	Z.M	DESIGNS DEPARTMENT
TCD	B.Y.	
CKD		D 31 508A2
APPD	J.P.	

CHANGE	ISS
1 - 8 - 72	1
22 - 11 - 72	2

AM15/503P SUB ASSEMBLY No. 3 CIRCUIT



TRANSISTOR TERMINATIONS  
VIEW ON LEADS



- BFX 37
- 2N930
- 2N2904A
- BCY 71

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OC  
A2

# AM15/503P (SUB ASSEMBLY No. 3) CIRCUIT

PARTS LIST D31504A4

DRN	Z M	DESIGNS DEPARTMENT
TCD	B Y	
CKD		
APPD		

## D31510A2

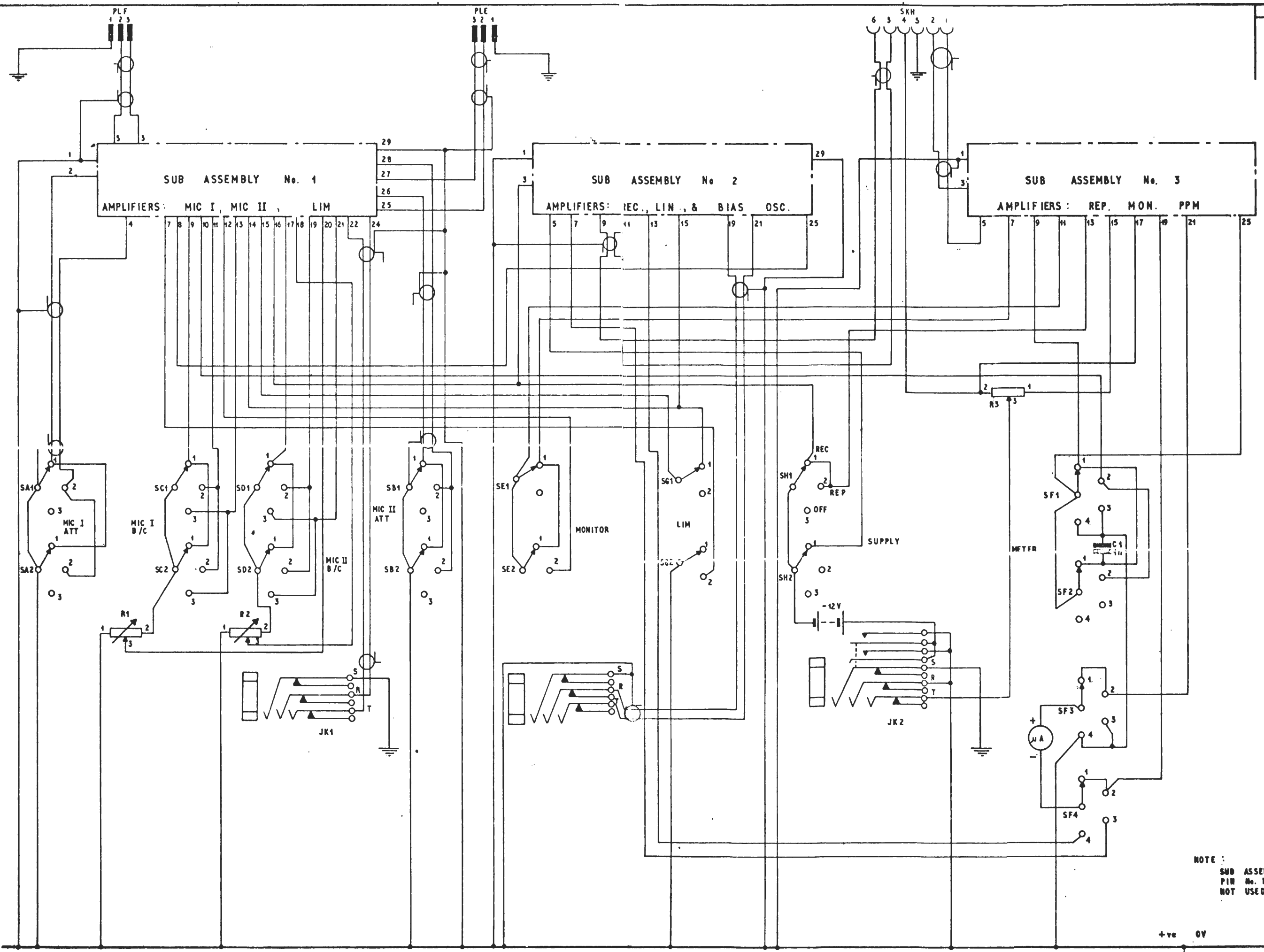


CHANGE  
1-8-72  
4-1-73

D 31503 A 2

AM15/503P AMPLIFIER RECORDING MAGNETIC

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NOTE:  
SUB ASSEMBLYS 1, 2, 3  
PIN No. NOT SHOWN ARE  
NOT USED.

+ve 0V

PARTS LIST D31504A4

AM15/503P (AMPLIFIER, RECORDING, MAGNETIC)

DRN.	Z.M.	DESIGNS	DEPARTMENT
TCD.	S.Y.		
CKD.			
APPD.	JSP	D31503A2	