

SECTION 8

VARIABLE-FREQUENCY OSCILLATORS

OSCILLATOR TS/5

The tone source TS/5 provides a source of a.c. test current at any desired frequency between zero and 10 kc/s.

Circuit Description (Figs. 12 and 12A)

The oscillator is of the heterodyne type and consists essentially of two oscillators, one of fixed and one of variable frequency, followed by an anode-bend detector stage; this is followed by a three-stage amplifier having two AC/P1's in the output stage. The frequencies generated by the fixed and variable oscillators, respectively, are both impressed upon the anode bend detector and a component at the difference frequency is produced at its output.

The oscillators are of the self-biasing type with tuned anode circuits inductively coupled to their own grid circuits and to the grid circuit of the anode bend detector. The coupling of the fixed frequency oscillator is made via a filter circuit which passes the fundamental frequency but rejects the harmonics. A variable capacitor designated *Filter* is included in this circuit. This capacitor is adjusted on installation but the setting should be checked periodically, especially after the removal of any of the screening boxes, since slight deformation of these may effect the inductance of the coils.

To carry out this adjustment *TS Out* should be connected to *Amp. Det. In.* The tone source should then be set to any frequency and the level adjusted, either by means of the tone-source volume control or the level switches of the amplifier detector, so that, with the *Galvo* key on the transmission measuring set thrown to *Meas. Cct.* or with the *Amplifier Detector* key of the thermo-couple panel thrown to *Adjust*, the galvanometer reads approximately $\frac{3}{4}$ scale. The filter tuning capacitor should then be adjusted to obtain a maximum reading on the galvanometer.

The frequency of the variable oscillator is adjusted by varying the shunt capacitance in its tuned anode circuit. Three variable capacitors are provided in this circuit, one being designated *Zero* and the others *1* and *2* respectively. The *Zero* adjustment capacitor is used to bring the variable-frequency oscillator into synchronism with the

fixed-frequency oscillator, with the other two capacitors set at zero, as an initial adjustment. The setting of capacitors *1* and *2* for any desired frequency is then given by the calibration chart.

The dials fitted to capacitors *1* and *2* are of a special slow-motion type. The slow-motion knob is engraved in fifths of a main dial division and rotates once for two main-dial divisions. The drive is a positive one and, with the large step-down gear ratio of 100/1 care should be taken not to force the capacitor beyond the stops at either end of the main scale. The slow motion can be disengaged by pulling out the slow-motion knob and re-engaged by pushing upwards the catch below this knob. The arrangement of the gears is such that the slow-motion always re-engages correctly, relative to the engraving on the main and sub-dividing scales.

The output circuit of the detector is coupled to the first stage of the amplifiers via a low-pass filter circuit which is designed to suppress components at the original frequencies.

Resistance-capacitance coupling is employed between the first two stages of the amplifier and resistance-capacitance-transformer coupling between the second stage and the push-pull output stages. The valves are of the indirectly-heated type and grid bias to the detector and amplifier stages is obtained automatically from resistors included in each h.t. return circuit. Volume-control potentiometers are provided in the grid circuits of the first two amplifier stages for adjusting output. The potentiometer in the input of the second stage provides coarse adjustment and that in the input of the first stage fine adjustment. A 100,000-ohm rheostat in series with the potentiometer in the grid circuit of the second stage is set so as to give 15-volt maximum output when the tone source is used with a transmission measuring set, TM/1, and 10-volt maximum output when TS/5 is adjusted to give 20-volt maximum output into 600-ohm resistance load with the 100-kilohm rheostat all out.

Valve Data

	Anode Current mA	Fil. Volts	Fil. Amps.
Fixed Oscillator AC/P	4	4	1

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	<i>Anode Current mA</i>	<i>Fil. Volts</i>	<i>Fil. Amps.</i>
Variable Oscillator AC/P	13	4	1
Detector AC/HL	—	4	1
Amplifier Stage 1, AC/P	6	4	1
Amplifier Stage 2, AC/P	6	4	1
Amplifier Stage 3, 2 AC/P1's	40	4	2
Total Feed, 69 mA.			
H.T. Supply:			
Rectified a.c. 250 V.			
Battery Supply.			
L.T. Supply, 6 V (adjusted to 4 V by series resistor).			

Volume Control

Type	Resistance	No. of Studs	Loss per stud	Loss on lowest stud
P.8	100 kΩ	21	0.1 db	2 db (Total)
P.4	100 kΩ	21	2.0 db	Infinite
			(down to stud 6)	
		Studs 6-5	3 db	
		5-4	4 db	
		4-3	6 db	
		3-2	7 db	
		2-1	Infinite	

Impedances

Output No. 1 $Z = 300 \Omega$
 „ No. 2 $Z = 600 \Omega$.

Maximum output available into 600 Ω (harmonic content not exceeding 1%) = 25 db approx.

Operation

To adjust the tone-source oscillator to send at any desired frequency, the following operations should be carried out:—

- (1) Set the frequency dials 1 and 2 at Zero.
- (2) Adjust the zero dial, either by listening on headphones plugged into the output jack, or more accurately, by observing the milliammeter in the detector feed circuits, until the frequency of the 'beats' does not exceed one per second.
- (3) Set the frequency dials 1 and 2 to the reading indicated in the calibration table corresponding to the desired frequency.

OSCILLATOR TS/7

The Variable-frequency Tone Source TS/7 is a commercial product. It is a beat-frequency oscillator having a frequency range from 30 c/s to 14 kc/s and will deliver a maximum output of + 20 db into a load impedance of 600 ohms.

The unit comprises a fixed oscillator and a variable oscillator, a portion of the output of each oscillator being fed into an h.f. amplifier.

The h.f. amplifier is coupled to the grid of the detector stage, thus producing a beat note, the frequency of which is determined by the setting of the variable oscillator control. The frequency of the beat note will be equal to the difference in frequency between the two oscillators.

The high-frequency components, comprising the oscillator frequencies and that produced by their sum, are rejected by the low-pass filter following the detector stage.

The detector stage feeds into two l.f. stages, the second of which feeds the output transformer. Sending levels are set by means of an H-network attenuator connected across the output transformer. The network has a range of + 20 db to - 50 db.

H.T. and l.t. supplies are derived from a mains unit supplied by the makers of the tone source. The unit is designed to operate from either 200/250 or 110/115-volt single phase 50-c/s supplies.

The tone source utilises six valves, Type AC/SP3B, which operate as follows:—

- V1 Fixed Oscillator connected for triode working.
- V2 Variable Oscillator connected for triode working.
- V3 H.F. Amplifier connected for pentode working.
- V4 Anode-bend Detector connected for triode working.
- V5 L.F. Voltage Amplifier connected for pentode working.
- V6 L.F. Power Amplifier connected for pentode working.

Circuit Description (Fig. 13)

Fixed Oscillator

The grid and anode circuits of the fixed oscillator valve V1 are inductively coupled through L1, L2, a fraction of the output signal being fed to the h.f. stage V3 via L3. Tuning is effected by C4-C7, C5 being variable to cover the beat frequency range of 0-600 c/s. Fig. 8.1 shows two separate tuning

controls, labelled *L.F. Scale* and *H.F. Scale* respectively, the *L.F. Scale* control being associated with the so-called 'fixed' oscillator. The reason for this arrangement is to give wide scale adjust-

of the first l.f. stage, V5. The low-pass filter is designed to reject the h.f. components of the detector output and to pass the l.f. beat frequencies to the l.f. stages.

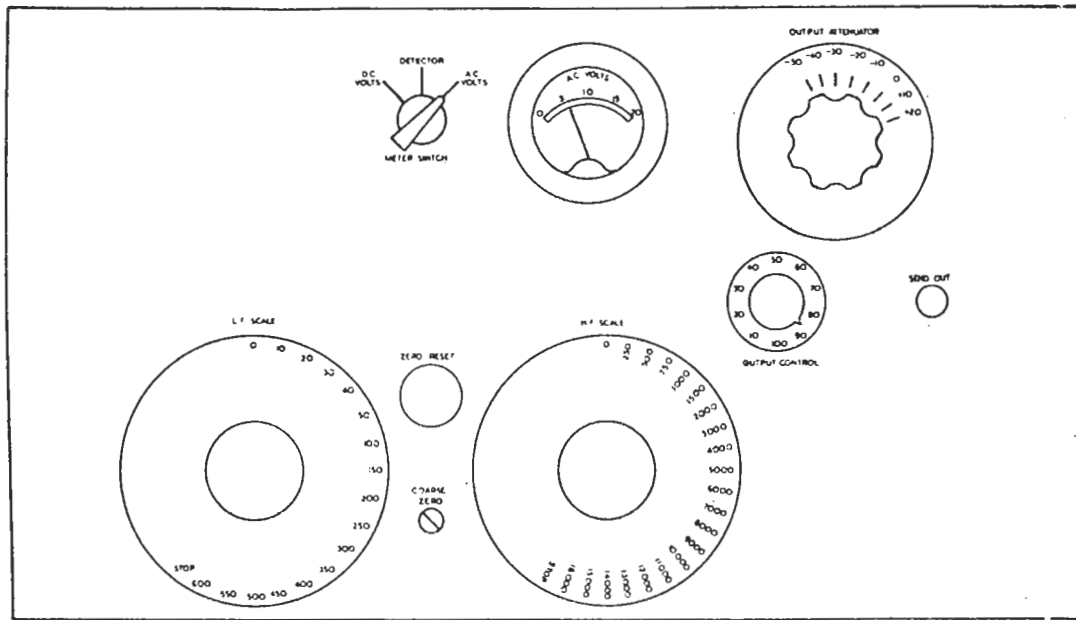


Fig. 8.1. Face Panel TS/7

ments at low frequencies; if there were no adjustment of the 'fixed' oscillator the h.f. scale would be too cramped at the lower end.

Variable Oscillator

The Variable Oscillator, V2, employs a circuit similar to that of the fixed oscillator. The anode coil L5 is loosely coupled to L6 so that a fraction of the output of V2 is coupled to the grid of the h.f. stage V3.

H.F. Stage

The h.f. Stage, V3, comprises a straightforward aperiodic amplifier, choke-capacitance coupled to the grid of the detector stage.

Detector Stage

The Detector, V4, functions as an anode-bend detector. The anode circuit is coupled to the first l.f. stage through a low-pass filter comprising L8, L9, C21, C22, C23, R22, R23.

R23 acts as a volume control in the grid circuit

A.F. Stages

The two a.f. stages are worked under pentode conditions and are resistance-capacitance coupled to each other. Negative voltage feedback is injected into the cathode circuit of V5 from the anode of V6 via R28 and C36. Negative current feedback is also applied by the omission of decoupling from the cathode resistor R26.

In some cases it has been found necessary to introduce frequency correction at this point by connecting a small capacitor with series resistance across R26, the effect being to reduce the feedback at the upper frequencies.

The output of V6 is choke-capacitance coupled to the output transformer T1. The secondary winding of the output transformer is tapped to give output impedances of 75 ohms and 150 ohms. Under normal conditions the 75-ohm tap is used.

Output Meter and Sending Circuit

The secondary of the output transformer is switched to a rectifier-type voltmeter, so that the level at this point, at all frequencies, can be kept constant at 15.5 volts (+ 26 db).

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Across this point is shunted a 1.2 kilohm fixed resistor, R31, and an H-type 600-ohm variable attenuator, R34, built out to 1.2 kilohm impedance by means of a 300-ohm resistor in each leg (R32 and R33). The output transformer is thus loaded with 600 ohms and the loss between this point and the attenuator input is 6 db, making the level at the attenuator input + 20 db relative to .775 volt r.m.s.

This arrangement is adopted so that the voltmeter reads the true source or open-circuit voltage, the source impedance of the unit remaining at 600 ohms under all conditions. The attenuator is calibrated from + 20 db to - 50 db sending levels into a 600-ohm load. These levels are absolute, provided that the level at the output of the transformer is maintained at + 26 db and the load resistance at 600 ohms. In order to check these conditions, the output voltmeter can be switched to the secondary winding of the output transformer.

Metering Arrangements

The meter switch is incorporated on the front panel. In position 1 it enables the output meter to be utilised for reading the h.t. volts from the mains unit and in position 2 the detector anode feed in milliamps. In position 3 the meter is placed across the tone source output via a Westector rectifier.

The full scale reading for d.c. volts is 400 (scale readings to be multiplied by 20).

Mains Supply Unit

The mains supply unit, supplied by the makers of the tone source, is designed to work from 110-115 volts or from 200-250 volts, the primary of the transformer being suitably tapped to accommodate these voltages. On installation the transformer voltage tap is set to the voltage obtaining from the local power supply.

A valve rectifier of the UU/4 type is used in the h.t. supply circuit, the supply being split into two sections. For anode and s.g. supplies to the output stage, choke-capacitance smoothing is used, both anode and screen being supplied with the full output voltage, except for the voltage drop across the smoothing chokes in the mains unit, which will be small.

Additional resistance-capacitance smoothing is introduced in the h.t. supply to the remaining stages.

L.T. supply to all valves is taken from the 4-volt winding of the mains transformer.

Both oscillator and mains unit are provided with 4-pin sockets, connection being made by means of double-ended 4-pin plugs.

Valve Data

Valve	Anode Current mA	Screen Current mA	Fil. Volts	Fil. Amps.
Stage 1, AC/SP3B	2.6	—	4	1
Stage 2, AC/SP3B	2.8	—	4	1
Stage 3, AC/SP3B	2.2	0.75	4	1
Stage 4, AC/SP3B	1.05	—	4	1
Stage 5, AC/SP3B	1.65	0.6	4	1
Stage 6, AC/SP3B	15.0	7.0	4	1

Total Feed, 33.7 mA.

H.T. Supply, Stages 1-5, 230 V; Stage 6, 290 V.

L.T. Supply, 4 V a.c.

Total Harmonic Content

< 0.5 per cent. at 100 c/s and 1 kc/s (output at + 20 db).

Operation

Turn down both tuning dials to zero and adjust to zero frequency by means of the *Adj. Zero* control. For this operation, the meter switch should be set to position 2 (measuring detector current) and the control adjusted for zero beat. Care must be exercised that the meter indicates true zero beat, since a condition can be obtained where, if the setting is a long way from zero frequency, the meter will appear stationary. This may be checked by switching the meter to position 3 (measuring a.c. output volts), when it will read zero for the true zero beat frequency setting. An additional check can be made by listening to the output on headphones, with the output attenuator set to give maximum output.

Set frequency to 1 kc/s, check the a.c. volts and adjust the a.c. volts control until the meter reads on the red line at 15.5 volts. Under this condition a level of + 26 db is available at the output of the transformer. For very accurate work, the voltage should be adjusted to 15.5 at each frequency.

For frequencies below 600 c/s set the h.f. control to 0 and select the required frequency on

the l.f. control. For frequencies of 600 c/s and above, set the l.f. control to 0 and select on the h.f. control.

There is an overlap between the two controls at certain low frequencies which permits selection on either control, provided that one is set at 0.

The output of the TS/7 proper may be used for sending tone to line at levels between +20 db and -50 db. On the standard a.c. test bay the TS/7 output is normalised to the variable attenuator AT/19 input so that the output of the AT/19 can be used should circumstances make this desirable.

For sending levels below -50 db, it is essential to connect a repeating coil between the output of the TS/7 and the input to the AT/19. A repeating coil is provided on the a.c. test bay for this purpose, its input and output being terminated on jacks. When using the repeating coil, the output level of the TS/7 must be maintained as near to zero as possible in order to minimise hum pick-up in the repeating coil. Set the AT/19 to maximum attenuation and introduce the additional attenuation required by adjustment of the variable attenuator on the TS/7 itself.

OSCILLATOR TS/8

The Variable-tone Source TS 8 was designed to the specification of the BBC Lines Department and is produced commercially. It is supplied as

The tone source consists of a variable oscillator, the output of which is fed in push-pull into the grids of a pair of detectors, and a fixed oscillator which is fed into the grid of a buffer stage, the output of which is connected to the detector grids in parallel via the centre tap of the output coil of the variable oscillator.

Coupling between the two oscillators is, therefore, effected in the detector stage, producing a beat note, the frequency of which is determined by the setting of the tuning capacitor of the variable oscillator.

The beat note is passed to the output stage via a low-pass filter. The push-pull output stage is capable of delivering tone to line at levels of +20 db, +10 db, or zero, with regard to 0.775 volt r.m.s., the frequency range being from 10 c/s to 10 kc/s.

The tone source utilises AC/SP3 valves under pentode working conditions, the power supply being taken from a standard mains unit, Type MU/16.

Circuit Description (Fig. 14)

The Variable Oscillator

The Variable Oscillator, V1, is built as a separate unit within its own screening box and comprises an orthodox inductively-coupled anode and grid circuit.

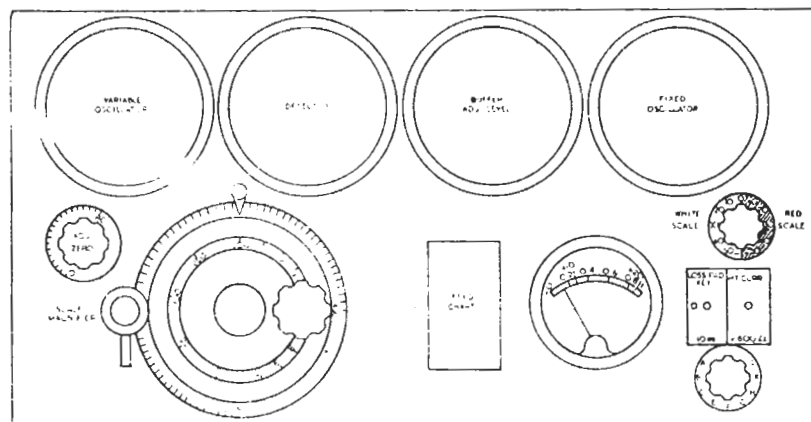


Fig. 8.2. Face Panel TS/8

an alternative to the Tone Source TS/7, and where installed at stations having standard apparatus bays, is mounted on the A.C. Test Bay in place of the TS/7.

The anode and grid coils are incorporated in the transformer T1, the anode coil being tuned by the fixed capacitor C5 and the variable capacitor C6, an additional small variable capacitor C7 being

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provided for zero setting. The grid circuit is aperiodic.

The transformer T1 has an additional winding which provides inductive coupling between the anode coil and the grids of the push-pull detector stage. A screen is inserted between this coil and the anode coil to prevent capacitance coupling. The anode circuit is decoupled by R1, C1, additional decoupling being provided by C41, the high capacitance of C41 being necessary to prevent interference from the 50-c/s mains supply. C41 is mounted outside the screening box because of limitation in space.

The Fixed Oscillator, V2

The Fixed Oscillator, V2, is mounted in a separate screening box, its circuit arrangement being similar to that of the variable oscillator except for the omission of the variable tuning capacitor. A small variable capacitor is fitted to provide a frequency increment of ± 50 c/s. This provision supplements the normal tuning arrangements to the extent that frequencies lying outside the calibrated scales of the main tuning dial may be obtained by suitable adjustment of the increment capacitor. Its application is explained under the heading 'Operation.'

The oscillator is tuned at a frequency of 100 kc/s by the capacitor C12 and the primary of the transformer T2, the output coil of T2 being fed into the grid of the buffer stage.

The Buffer Stage

The inclusion of a buffer or separator stage in a beat-frequency oscillator is an effective means of separating the two oscillators and thus preventing direct coupling between the two.

The output of the fixed oscillator is connected to the input of the buffer stage, the output of the latter being connected to the grids of the detector valves V4, V5. Since a valve is interposed between the fixed and variable oscillator outputs, direct coupling between the two oscillators is eliminated.

The grid of V3 is connected to the output coil of the fixed oscillator via the potential divider R15, P1, the latter acting as a volume control. The anode of V3 is tuned to the frequency of the fixed oscillator and connected to the detector grids through the centre tap of the output coil of the variable oscillator. Anode and screen grid decoupling is similar to that in the oscillator stages except that the additional anode decoupling has not been included. The circuits so far described

consist of a variable oscillator fed direct to the detector grids in push-pull and a fixed oscillator, fed to the same grids in parallel via a buffer stage.

The Detector Stage, V4, V5

The detector stage valves V4, V5, are arranged in push-pull. The output of the detectors comprising the audio beat-frequency (produced by the difference between the variable and fixed frequencies) and the unwanted higher frequencies, is fed to the low-pass filter which is designed to reject all frequencies above 30 kc/s.

In order to compensate for the small losses introduced by the low-pass filter at the higher audio frequencies, the equalising networks C37, R31, and C38, R32 have been included.

The Output Stage, V6, V7

The input to the push-pull output valves V6, V7 is taken direct from the output of the filter. The anodes are connected to the h.t. supply via the split primary of the output transformer T4, the secondary winding of which is connected to the output terminals via the contacts of the *Loss Pad* key and the top travellers of the meter key. The cathode return circuit is taken via the centre-tapped feedback winding of T4 and the bias resistances R29, R30. Since R29, R30 are shunted by the small capacitance by-pass capacitors C33, C34, current feedback as well as voltage feedback is applied to this stage, the current feedback being reduced at the upper frequencies.

A rather flat acceptor circuit, L5, C35, is connected across the output winding of T4, the circuit being made to resonate at approximately 100 kc/s in order to suppress any remaining interference from the primary oscillators.

The Output Circuit

The secondary winding of the output transformer, T4, is taken to the travellers of a two position *Loss Pad* key. With this key in the central position the maximum output level, as determined by the setting of the buffer stage *Adj. Level* control, is available for sending to line. With the *Adj. Level* control in the maximum position, this level is +20 db.

A 10-db loss pad is connected across one pair of contacts of the *Loss Pad* key. An output level of zero db may be obtained by setting this key central, adjusting the *Adj. Level* control for a meter reading of +10 db and then setting the key to 10 db *Loss*.

The Meter Circuits

The output of the *Loss Pad* key is taken to the top travellers of the *Meter* key which, in the central position, is connected to the output terminals. In this position, the meter itself is disconnected. In the *V600* position of the meter key, the output of the tone source is connected across the meter rectifier, the output terminals being disconnected.

The meter is calibrated for output levels of either + 20 db or + 10 db, so that with the *Loss Pad* key in the central position and the *Meter* key in the *V600* position, either of these levels may be obtained by suitable adjustment of the *Adj. Level* control. As previously stated, an output level of zero db may be obtained by placing the *Loss Pad* key to *10 db Loss* and adjusting the *Adj. Level* control for a reading of + 10 db on the meter. In the *Feeds* position, the meter is connected to the *Meter Selector* switch without interrupting the output circuit of the tone source. In this position, therefore, the meter can be connected across the shunt resistors corresponding to the various anodes and screen grids, by the manipulation of the *Meter Selector* switch.

Valve Data

Valve	Anode Current mA	Screen Current mA	Fil. Volts	Fil. Amps.
Stage 1, AC/SP3B	·9	·3	4	1
Stage 2, AC/SP3B	·9	·3	4	1
Stage 3, AC/SP3B	·9	·3	4	1
Stage 4, AC/SP3B	2·6	·8	4	1
Stage 5, AC/SP3B	2·6	·8	4	1
Stage 6, AC/SP3B	15·0	5·0	4	1
Stage 7, AC/SP3B	15·0	5·0	4	1
Total Feed, 50·4 mA.				
H.T. Supply, 300 V.				
L.T. Supply, 4 V a.c.				

Total Harmonic Content

< 0·5% at 100 c/s. < 0·25% at 1 kc/s.
(Output at + 20 db) (Output at + 10 db)

Operation

To operate the tone source, switch on the mains unit and proceed as follows:—

To Check Zero: Set the main tuning and frequency-increment dials to zero. Set *Meter* key to *V-600* ohms and *Loss Pad* key to 0 db. Adjust the *Adj. Zero* control for zero beat on the meter.

To Check Level: Set the main tuning dial to 1 kc/s, leaving the meter and *Loss Pad* keys in the *V-600* and *0-db* positions. Adjust the *Adj. Level* control to the buffer stage to obtain a reading of + 20 db or + 10 db on the meter as required.

Sending Tone to Line

Carry out adjustments as indicated above.

For a sending level of + 20 db or + 10 db set the *Loss Pad* key to the central (zero attenuation) position. Set the *Meter* key to *V-600* and adjust the buffer stage *Adj. Level* control until the required level is indicated on the meter.

Re-set the *Meter* key to *Line* position.

For a sending level of zero db set the *Loss Pad* key to 0 and adjust the *Adj. Level* control for a meter reading of + 10 db. Then set the key to *10 db Loss*.

Re-set *Meter* key to *Line* position.

It is important to note that the above adjustments obtain for an output load of 600 ohms only. In cases where the tone source is required to feed into a load other than 600 ohms, the output level should first be obtained on an amplifier detector or other suitable measuring instrument.

For sending levels between 0 db and - 55 db use should be made of the variable attenuator AT/19. Plug the TS/8 to the AT/19 input. Set the AT/19 controls to the attenuation required.

For levels below - 55 db, it is necessary to check the output level on the AD/4. Set the TS/8 *Loss Pad* key to 10-db loss. Plug the output jack to the AD/4 600-ohm input and adjust the level control on the TS/8 to obtain the additional attenuation required. For example, to obtain a level of - 70 db, reduce the level of the TS/8 until the AD/4 reads mid-scale with its control set at - 15 db. Now plug the output of the TS/8 to the AT 19, with the AT/19 set for maximum attenuation, i.e., - 55 db.

The main tuning dial has two sets of calibrations, one in the form of an ivory scale, calibrated for standard frequency runs, and the 0-450 scale engraved on the dial itself. For normal frequency runs, the *Frequency Increment* dial should remain

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at zero, tuning being effected by the main calibrated tuning dial.

For miscellaneous frequencies or, where great accuracy is required, the 0-450 degree scale must be used in conjunction with the calibration chart provided with the tone source.

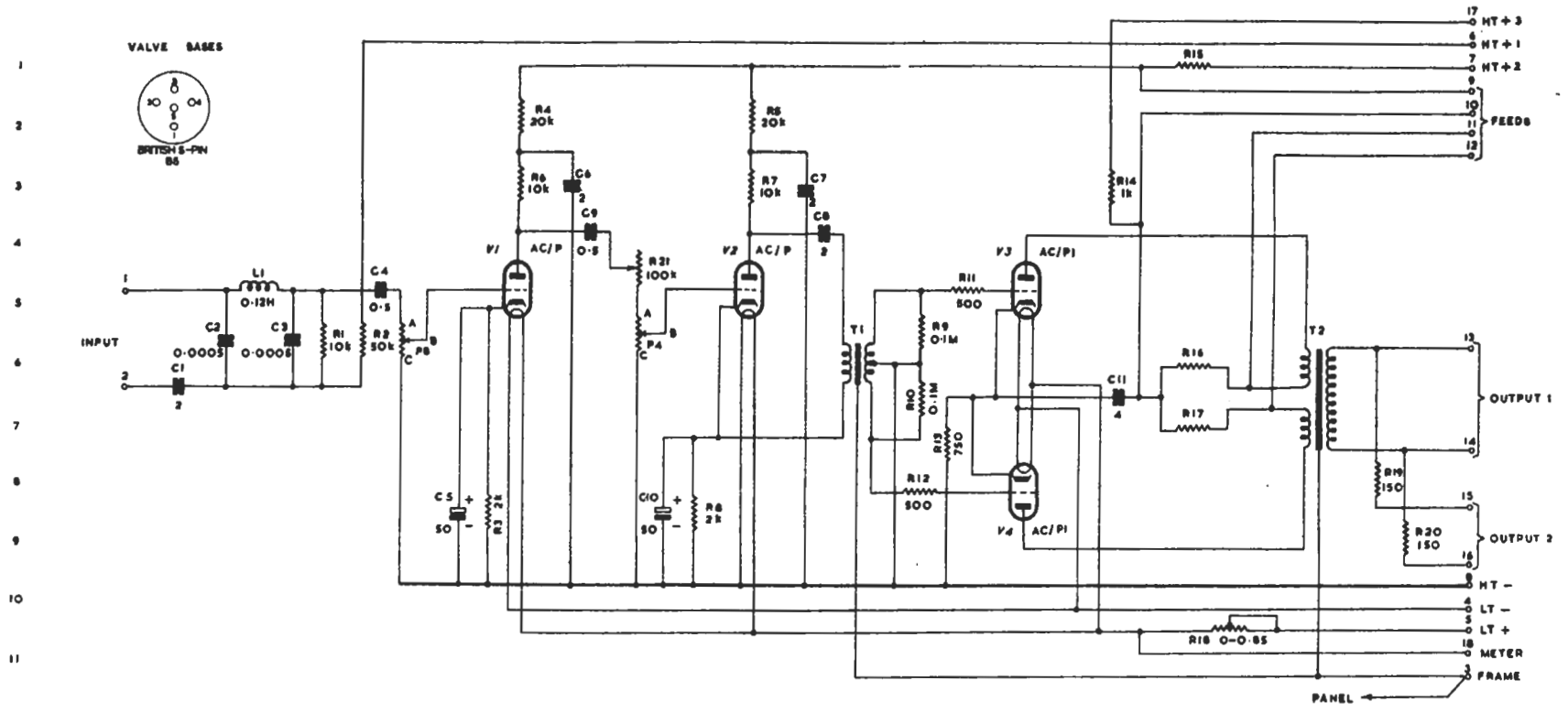
To obtain frequencies not listed on the chart, set the 0-450 degree scale to the nearest listed frequency and adjust the *Frequency Increment* dial accordingly; e.g., for a frequency of 256 c/s, supposing the nearest listed calibration to be 248 c/s, set the main tuning dial to the listed scale reading, and the increment dial to 8 on the red scale. (For a frequency of 244 c/s, the increment dial would be set to 4 on the white scale).

Checking Feeds

Set *Meter* key to *H.T. Current* and *Meter Switch* to the appropriate setting. A table for these settings is given below:—

	mA.
A. Fixed Oscillator Anode and S.G. Current	1.2
B. Variable " " " "	1.2
C. Buffer " " " "	1.2
D. Anode Current Detector, V4	2.6
E. " " " V5	2.6
F. S.G. " " V4	0.8
G. " " " V5	0.8
H. Anode " Output V6	15
I. " " " V7	15
J. S.G. " " V6	5
K. " " " V7	5

A B C D E F G H J K L M N O P Q R S T U V W



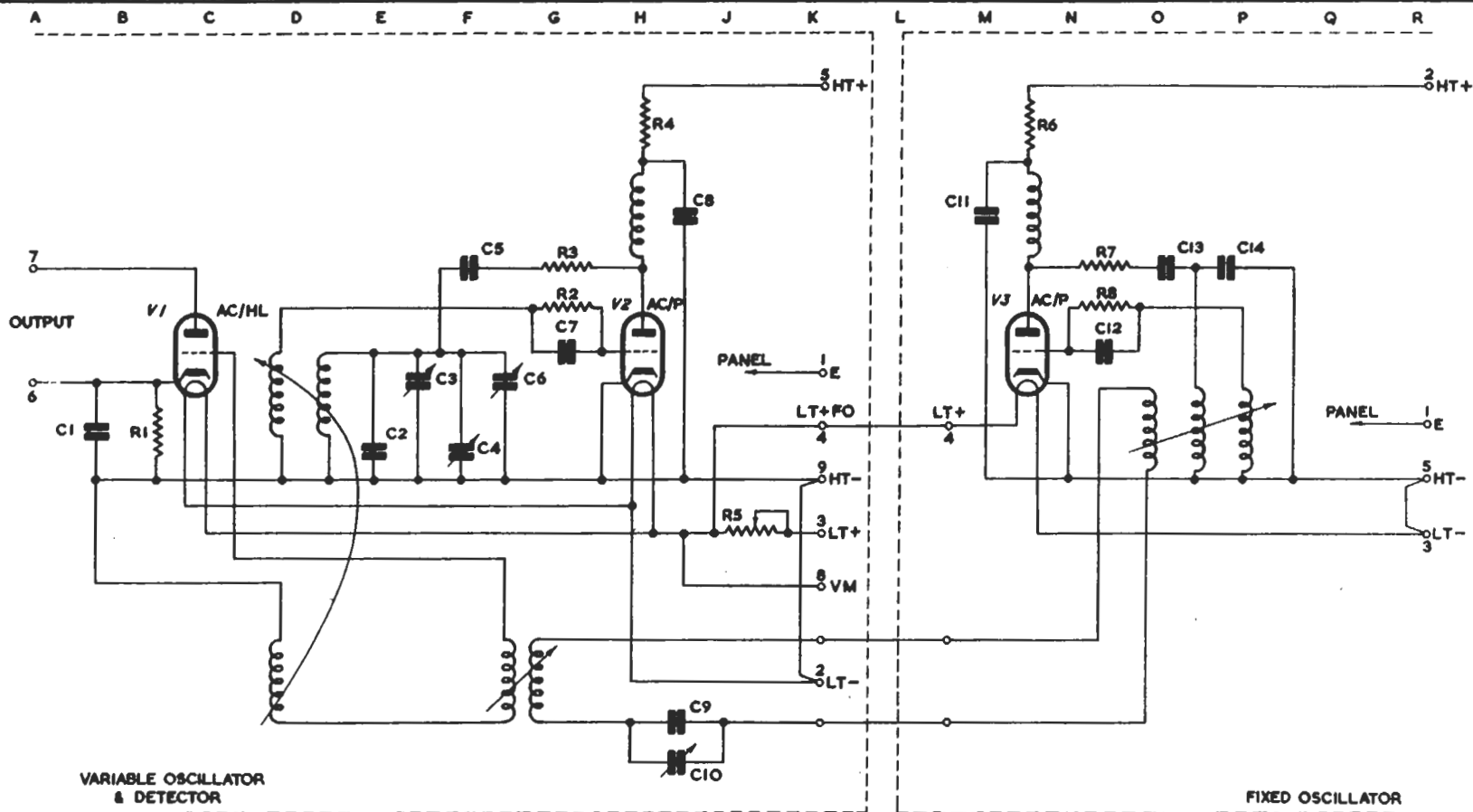
VALVE BASES



COMP	LOC	TYPE	COMP	LOC	TYPE	COMP	LOC	TYPE	COMP	LOC	TYPE
C1	A4					R7	L3		R18	T11	
C2	B4					R8	K8		R19	W8	
C3	B4		L1	B3		R9	N4		R20	W9	
C4	D5					R10	M7		R21	J5	
C5	F9					R11	O5				
C6	H3		R1	C6		R12	N8				
C7	M3		R2	D6		R13	O8		T1	M6	No 128
C8	M4		R3	F9		R14	R4		T2	V7	No 145
C9	H4		R4	G2		R15	S1				
C10	J9		R5	L2		R16	S6				
C11	R7		R6	G3		R17	S7				

TONE SOURCE TS/5 AMPLIFIER

FIG 12
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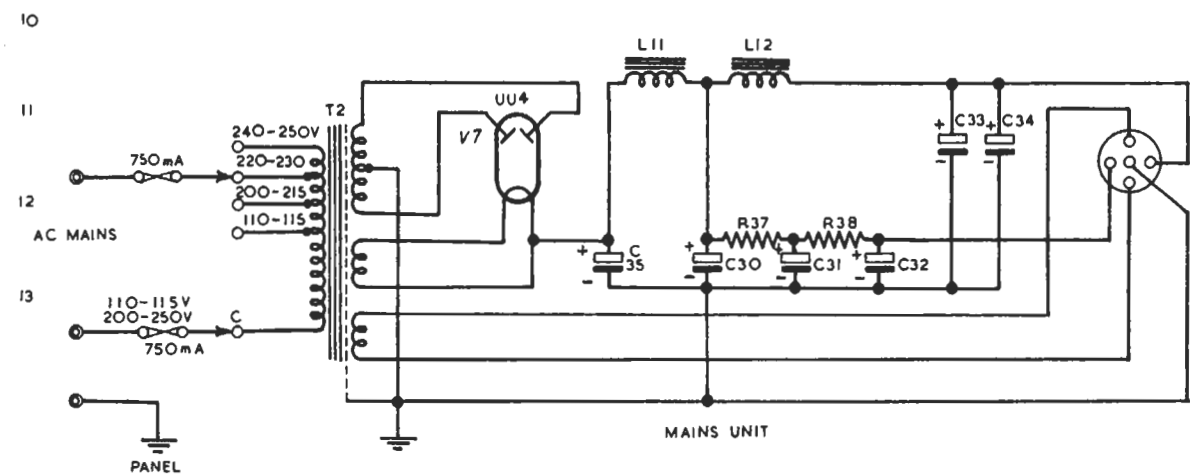
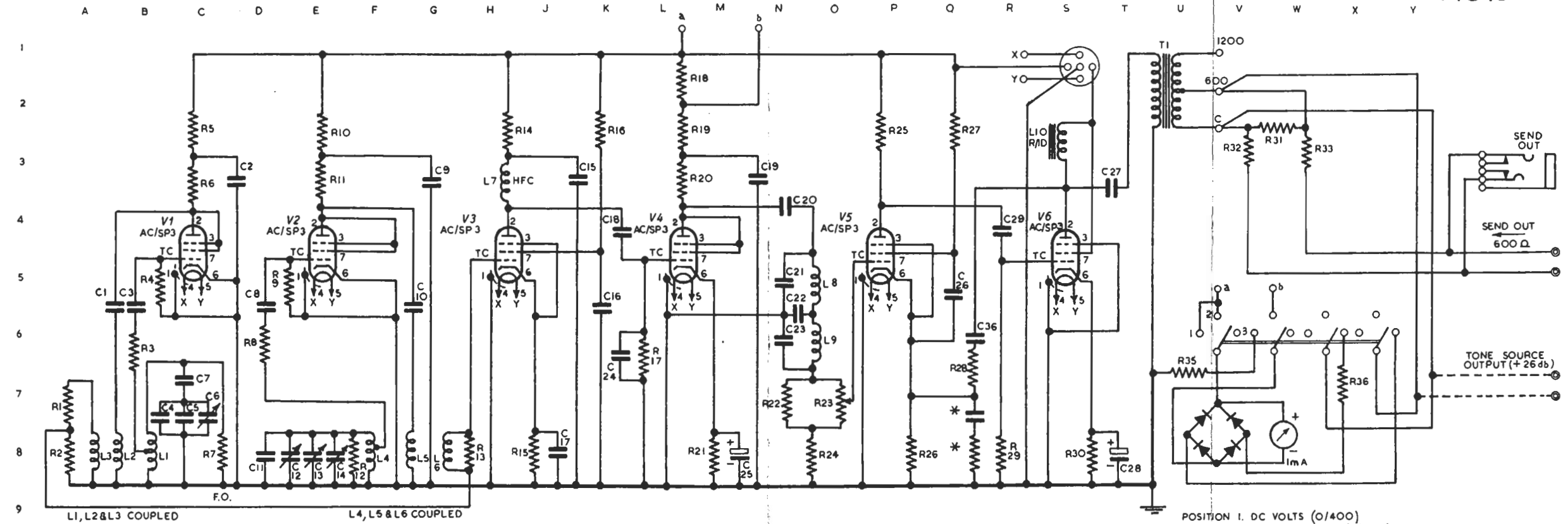
VARIABLE OSCILLATOR & DETECTOR

FIXED OSCILLATOR

COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	B5	50 μ F		C13	O3	.001 μ F	
C2	E5	.005 "		C14	P3	.005 "	
C3	F4	.00025 "					
C4	F5	.00025 "					
C5	F3	.001 "		R1	B5	4000 Ω	
C6	G4	.001 "		R2	G3	100 000 "	
C7	G4	.001 "		R3	G3	2500 "	
C8	J2	2 "		R4	H1	10 000 "	
C9	J8	.005 "		R5	J6	0-1.7 "	
C10	J9	.001 "		R6	N1	10 000 "	
C11	M2	2 "		R7	N3	2500 "	
C12	O4	.001 "		R8	N3	100 000 "	

TS/5 OSCILLATOR AND DETECTOR

S4050A/S4/AJP



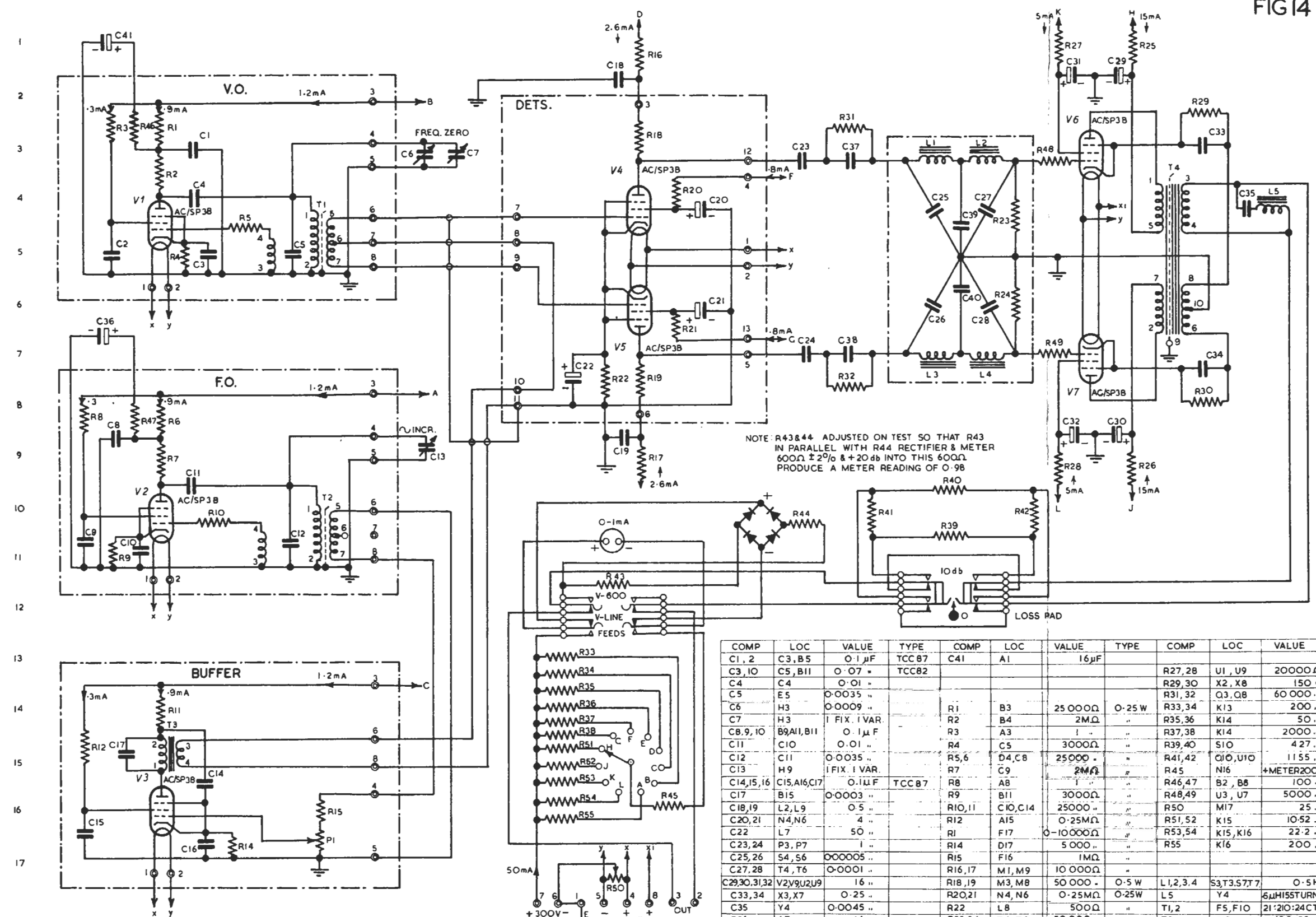
* THESE COMPONENTS ARE ONLY FITTED WHEN NECESSARY TO GIVE CORRECT FREQUENCY CHARACTERISTIC VALUES ADJUSTED DURING TEST.

POSITION 1. DC VOLTS (0/400)
2 DETECTOR FEED (0/2mA)
3 AC VOLTS (0/20)

COMP	LOC.	VALUE	TYPE	COMP	LOC.	VALUE	TYPE	COMP	LOC.	VALUE	TYPE
C1	A5	0.1 μF		C27	T3	4 μF		R18	L1	125 Ω	1/2 WATT
C2	D3	0.5 "		C28	T8	25 "		R19	L2	100 000 "	"
C3	B5	0.001 "		C29	R4	0.5 "		R20	L3	20 000 "	"
C4,5	B7,C7	0.0028 "		C30,35	F-L 11	8 "		R21	M8	5 000 "	"
C6	C7	0.0005 "		C36	Q6	4 "		R22	N7	100 000 "	"
C7	C7	0.0015 "						R23	O7		
C8	D5	0.001 "						R24	O8	10 000 "	"
C9	G3	0.5 "		R1	A7	24 Ω	1/2 WATT	R25	P2	50 000 "	"
C10	G5	0.1 "		R2	A8	3 "		R26		1 000 "	"
C11	D8	0.001 "		R3		5000 "		R27		250 000 "	"
C12	D8			R4		250 000 "		R28		150 000 "	"
C13	E8			R5		20 000 "		R29		250 000 "	"
C14	E8	0.0005 "		R6		50 000 "		R30		270 "	"
C15	K3	1 "		R7		250 000 "		R31		1 200 "	"
C16,17	K5,J8	0.1 "		R8		5 000 "		R32,33		300 "	"
C18	K4	0.001 "		R9		250 000 "					
C19	N3	1 "		R10		20 000 "		R35		400 000 "	"
C20	N4	0.5 "		R11		50 000 "		R36		17 000 "	"
C21	N5	0.0005 "		R12		250 000 "		R37		5 000 "	"
C22	N5	0.0004 "		R13		100 "		R38		5 000 "	"
C23	N6	0.0001 "		R14		20 000 "					
C24	K6	0.0008 "		R15		1 400 "					
C25	M8	250 "		R16		100 000 "		T1		402:1 5.62:1	
C26	Q5	0.5 "		R17		20 000 "		T2			

TONE SOURCE TS/7

54049A/S4/AJP



VARIABLE TONE SOURCE TS/8

COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1, 2	C3, B5	0.1 μF	TCC87	C41	A1	16 μF					
C3, 10	C5, B11	0.07 "	TCC82					R27, 28	U1, U9	20000 Ω	1W
C4	C4	0.01 "						R29, 30	X2, X8	150 "	0.25W
C5	E5	0.0035 "						R31, 32	Q3, Q8	60 000 "	
C6	H3	0.0009 "						R33, 34	K13	200 "	
C7	H3	1 FIX. I VAR.		R1	B3	25 000 Ω	0.25W	R35, 36	K14	50 "	
C8, 9, 10	B9, A11, B11	0.1 μF		R2	B4	2M Ω		R37, 38	K14	2000 "	
C11	C10	0.01 "		R3	A3	1 "		R39, 40	S10	4.27 "	
C12	C11	0.0035 "		R4	C5	3000 Ω		R41, 42	C10, U10	11.55 "	
C13	H9	1 FIX. I VAR.		R5, 6	D4, C8	25 000 "		R45	N16	+METER 200 "	
C14, 15, 16	C15, A16, C17	0.1 μF	TCC87	R7	C9	2M Ω		R46, 47	B2, B8	100 "	
C17	B15	0.0003 "		R8	A8	1 "		R48, 49	U3, U7	5000 "	
C18, 19	L2, L9	0.5 "		R9	B11	3000 Ω		R50	M17	25 "	
C20, 21	N4, N6	4 "		R10, 11	C10, C14	25000 "		R51, 52	K15	10.52 "	
C22	L7	50 "		R12	A15	0.25M Ω		R53, 54	K15, K16	22.2 "	
C23, 24	P3, P7	1 "		R1	F17	0-10000 Ω		R55	K16	200 "	
C25, 26	S4, S6	0.00005 "		R14	D17	5 000 "					
C27, 28	T4, T6	0.0001 "		R15	F16	1M Ω					
C29, 30, 31, 32	V2, V9, U2, U9	16 "		R16, 17	M1, M9	10 000 Ω					
C33, 34	X3, X7	0.25 "		R18, 19	M3, M8	50 000 "	0.5W	L1, 2, 3, 4	S3, T3, S7, T7	0.5H	
C35	Y4	0.0045 "		R20, 21	N4, N6	0.25M Ω	0.25W	L5	Y4	6 μH 15 STURNS	
C36	A7	16 "		R22	L8	500 Ω					
				R23, 24	T4, T6	50 000 "					
				R25, 26	W1, W9	5 000 "	2W	T4	W5		AAL/BRD