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ACOUSTICAL

QUAD II

AMPLIFIER

*... For the closest approach
to the original sound in
speech & music reproduction*

ACOUSTICAL

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AMPLIFIER

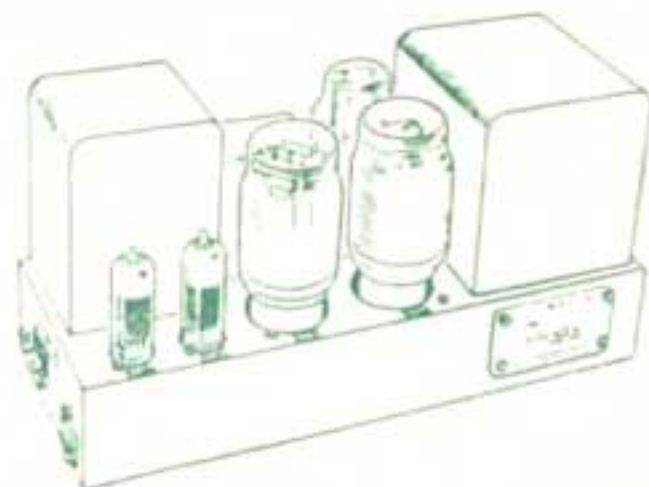
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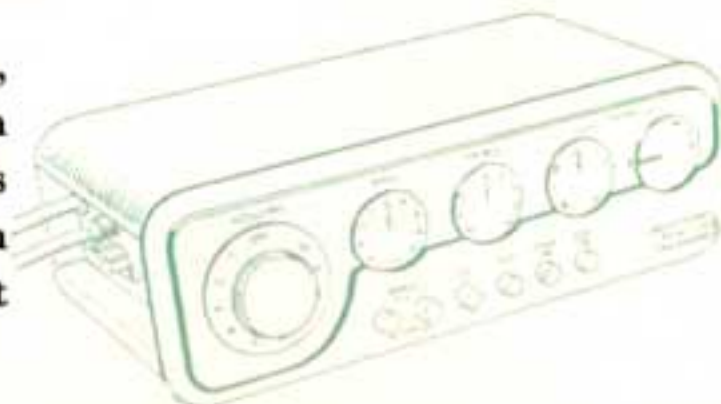
Introduction

*T*HIS booklet presents the full performance and specification of the QUAD II amplifier. Like its predecessor, it embodies outstanding features anticipating trends in both amplifier and associated equipment design. The importance of these features will be apparent to all who have followed the growth of high quality reproduction in recent years.



The criterion, as always, is that the reproduced sound shall be the closest approach to the original—that the enjoyment and appreciation of music may be unimpeded. This is reflected throughout the electrical and mechanical design. It is reflected, too, in the straightforward and logical system of control, achieved without the sacrifice of a single refinement or adjustment capable of contributing to the final objective.

The QUAD II for convenience of installation, is constructed in two units—the main amplifier and the control unit. Each is complementary to the other, offering in complete form the best which present techniques can devise.



A control unit is primarily necessary to amplify the programme signal, to correct—as far as this is possible—for various technical imperfections in that programme signal and to provide musical balance adjustments so that when further amplified and applied to the loudspeaker the resultant sound shall be a close approach to the original.

In the case of gramophone reproduction, the control unit is additionally required to match and amplify the weak signals from modern pickups and to equalise for non-uniformity in response deliberately introduced in gramophone recordings. If the final aim is to be realised, it is essential to take all these factors

into account in such a way that complexity of control does not defeat the objective. The appreciation of music requires the utmost concentration and this must not be distracted by problems of control or adjustment.

The original sound can be approached with the QC II control unit to a most subtle degree without specialised knowledge of any kind.

Quality Control Unit



Equalisation for every recording

RECORD EQUALISING

The control unit provides the correct equalisation for all of the records likely to be played on the equipment. Recording engineers are by no means agreed upon an optimum characteristic and indeed agreement is unlikely since the choice relies on a subjective assessment of a number of conflicting factors. The result is that most manufacturers of records use one or other of the 7 or 8 different characteristics generally recognised, of which four are in very popular use.

Push-buttons are used for the selection of characteristics for reasons which will now be apparent. The four red push-buttons on the control unit select the four main characteristics in a completely straightforward manner and cover all normal listening requirements. Engineers and experimenters, however, will be delighted to find that other characteristics are provided by combinations of buttons. For example, the NAB

STD 78



Ffrr 78



AES



COL LP



NAB



RCA (orth)



NAB—AES



BASS

TOP

characteristic is obtained by pressing AES and ffr 78 together : RCA Orthophonic by using AES, ffr 78 and STD78 : NAB bass with AES top by using AES and STD 78. All buttons relaxed still leaves the unit switched to gram but with completely uncompensated response—a useful feature for the calibration of pickups.

PICK-UP MATCHING

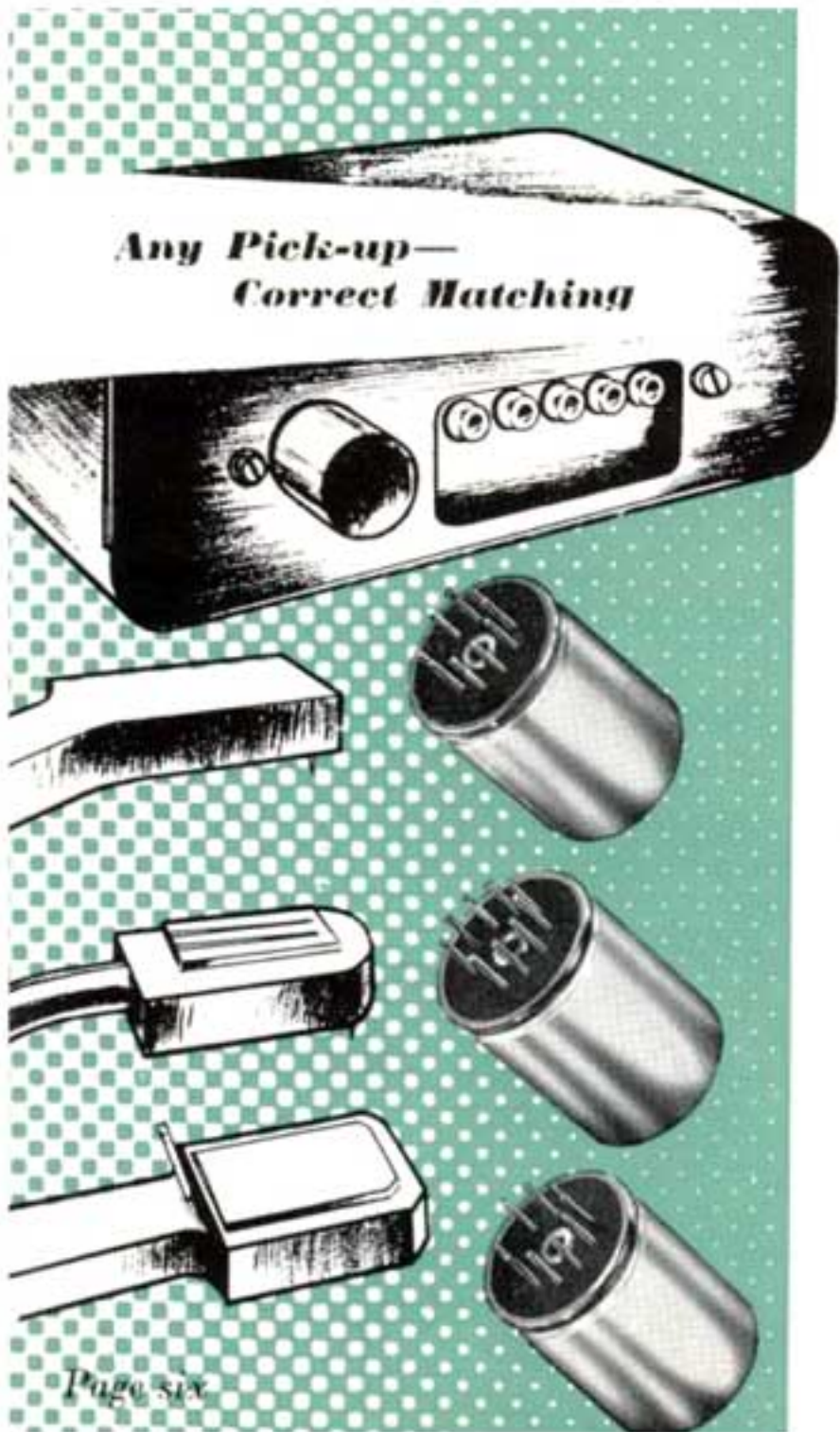
For the finest possible gramophone record reproduction, it is desirable that the amplifier input be correctly designed for the pickup with which it will be used.

Different types of pickups vary in respect of their source impedance, their required load impedance, amplitude or velocity characteristic and their output level. The circuitry for any pickup should meet all these requirements and at the same time provide optimum conditions for signal to noise ratio. In the QC II there is a small plug-in unit at the back. By inserting the unit appropriate to the pickup selected, the input circuit will be automatically correct in every respect for that pickup.

The advantages of this feature are rather more than the obvious one of correct matching, particularly where very low output pickups are concerned. Moving coil pickups, for example, can be matched directly without the use of any transformer, thus eliminating attendant problems of hum, lead capacity, etc.

Quality Control Unit





RADIO-MIC INPUTS. Three other inputs are provided on the control unit and they are switched by the two white push-buttons on the control panel. Two of these inputs may be used for radio or alternatively for microphone and radio respectively. The choice of these alternatives is available when selecting the pick-up adaptor unit. The third input is selected by pressing both white buttons simultaneously and is used for tape playback.

STANDARD INPUTS. Each control unit is supplied with a standard pickup plug-in unit designed to suit most velocity pickups and to provide two alternative radio inputs. The gramophone input as standard therefore, is in line with contemporary practice in other amplifiers so that an alternative plug will only be required for special pick-up arrangements.

TAPE RECORDINGS. Two sockets are provided for connection to a tape recorder, one for recording, and one for playback. The former is unaffected by the volume, balance and filter controls which should be used in the normal way when playing back. Gramophone compensation is effective.

EXTERNAL POWER SUPPLIES. Two sockets providing HT and LT supplies for tuner units are available on the control unit, the HT supply to each being switched when the appropriate radio bush-button is actuated. Where a tuner unit has its own power supply, this switched HT may be used to operate a relay within the receiver. A spare pin on each socket carries permanent HT for use where an unswitched supply is required.

CONTROLS

There are five controls on the front panel.

The large knob provides adjustment of volume level and combines the on/off switch for the complete equipment. The ACOUSTICAL nameplate is illuminated when the equipment is switched on.

The treble and bass controls are most subtly designed to obtain correct musical balance to suit the environment in which the equipment may be used. The remaining two controls adjust the equipment to suit the useful range of the particular programme material available and thus to reproduce the highest quality inherent in that programme.

A cancel position is fitted on the filter switch control. In this position, bass, treble, and filter controls are automatically by-passed to give a level response. Thus a switched reference standard is provided for useful comparison with the setting of controls found by aural assessment.

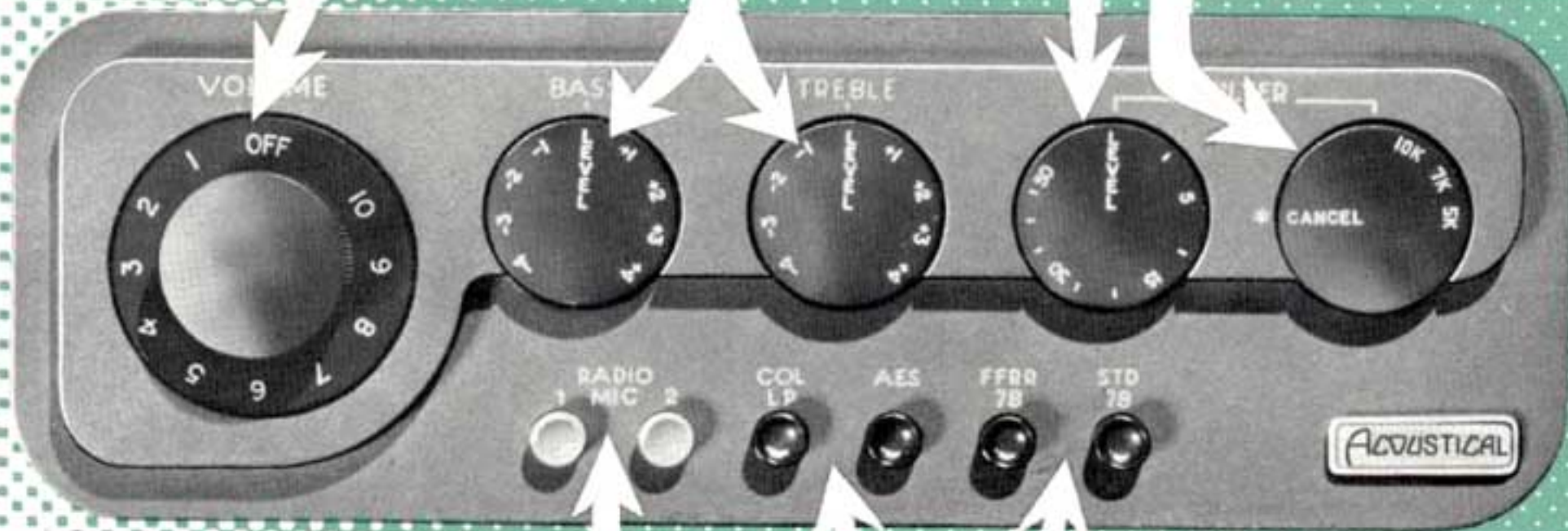
In use, the controls require the minimum of adjustment. The listening environment is usually constant so that the bass and treble controls, once set, will rarely require alteration. The filter switch should normally be set to 7k and the filter slope rotated from 'level' as may be required by imperfections in the recording or radio transmission. With older recordings or with poor radio reception, the filter switch should be in the 5k position. The 10k position is for very fine adjustment on the very best possible programme material.

Quality Control Unit

Bass and Treble Controls

Compensation for the environment in which the equipment is used.

Volume Control and on/off Switch



Filter Slope. Adjusting the filter characteristic for the finest performance inherent in the programme.

Filter Switch
Setting the filtering range.

Push Buttons

Selecting radio, tape or microphone inputs.

Push Buttons

Selecting playback characteristic.

CIRCUIT DESCRIPTION

The control unit employs three stages. The first stage provides pre-amplification for microphone and is also used in a versatile feedback loop for recording compensation. The second and third stages are enclosed in a further loop forming part of the treble and bass control, together with further amplification up to the filtering circuits. The output of the unit is 1.4 V.rms to which level all figures refer.

THE INPUT STAGE

The circuit of the first stage is completely versatile and is associated with the nine pin socket on the back of the unit.

Also wired to this socket is an impedance equivalent to the replay characteristic appropriate to the selected push-button. The range of impedance characteristics has a common value of 270,000 ohms at 1,000 c/s. The insertion of the plug-in unit completes the circuit to suit the pickup selected.

When the replay impedance is used directly in a parallel feedback circuit, the equivalent impedance at the valve input is less than 2 K Ω resulting in very low thermal noise. By suitable choice of series value, very high sensitivities can be obtained provided the pickup impedance itself is low.

By using stepped parallel feedback it is possible, effectively, to multiply the play-back impedance by a constant so that the arrangement can be made to provide a high signal/noise ratio for

Quality Control Unit



Quality Control Unit

the pick-up impedance to be used. The variable elements are within the plug-in unit so that optimum conditions can be provided for any pickup in terms of source impedance, load requirements and sensitivity, as well as providing for constant velocity or constant amplitude signal. The maximum sensitivities which can usefully be obtained are 3 mV at low impedance and 6 mV at 100 K Ω impedance, for full output at 1,000 c/s. Ample gain is therefore available for moving coil pickups without an intervening transformer and without noise.

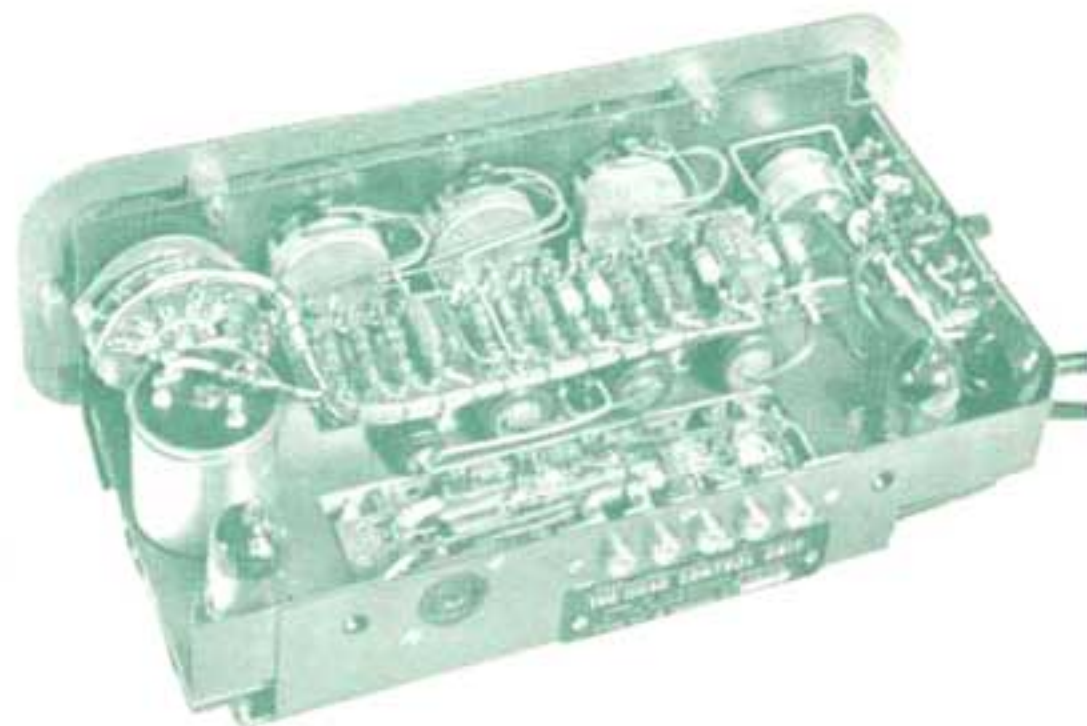
Permissible input overload is approximately 40db for plug-in units requiring 15 mV or more for full output, reducing to 20db for plug-in units providing maximum possible sensitivity.

The microphone input utilises the same stage with a lower load and a level response, fully loading with 1.5 mV at any impedance up to 100 K Ω .

The volume control follows the first stage and this is also the entry for radio inputs.

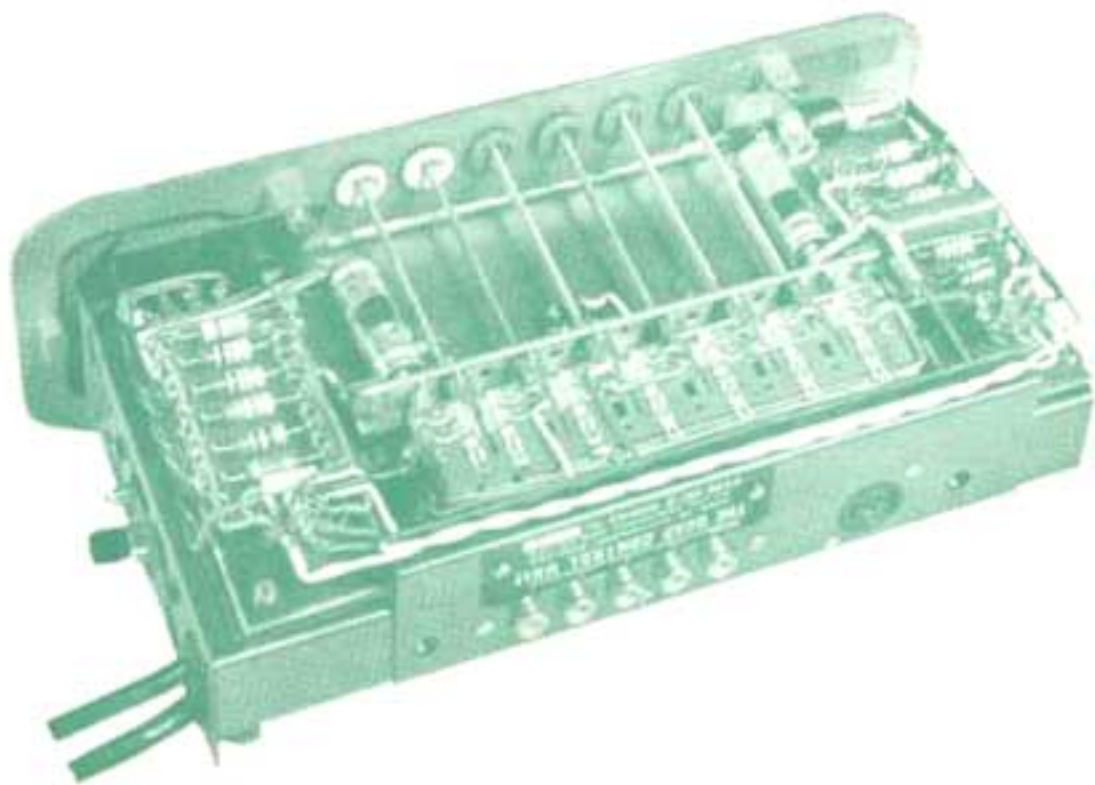
CONTROL STAGES

The continuously variable bass and treble controls are so arranged that the central position of their travel will always give a level response with virtually no error. The bass rise operates by varying an impedance in the feedback circuit of the two final stages and bass fall is obtained by varying an impedance in the top arm of the feed to the filters. These two impedances are of like



value so that a linear bass control is used. This is advantageous because a linear control does not appreciably change its scaling and any change in overall value will be symmetrical. Further, the two fixed capacitors are small and of like value, thus easy to match and extremely unlikely to drift.

In the maximum rise and fall positions, the maximum slope is 5db/octave and in intermediate settings the slope is gradually reduced to zero and at the same time the turnover point reduces in frequency. This is preferred



Quality Control Unit

to the step obtained by variation of amplitude or the constant slope obtained by variation of capacity alone.

The treble control operates both rise and fall in the feedback circuit. The slope is always asymptotic to zero so that a boost in musical brilliance in the treble musical register is not accompanied by boosted distortion at very high frequencies, nor is a reduction in the treble musical register accompanied by a complete loss of harmonics. This feature of musical balance control is, of course, only made practicable because of the independent filtering controls provided.

AUDIO FILTERING

The filtering is accomplished at the output of the control unit where the signal level is high and the impedance relatively low. This enables optimum circuitry to be used and does not preclude the use of inductors by hum problems.

Quality Control Unit

For the best possible performance, the filter must produce the required curve with the minimum of deleterious effects. The effect on transients due to ringing is a direct function of the response curve together with any mis-matching in the circuit. The first is a natural law and is, of course, common to all methods of filtering, the advantage of an LC configuration lying solely in the more favourable conditions for correct matching. With the added advantages of greater range and complete freedom from distortion, a properly matched LC network becomes the obvious choice when other circuit arrangements do not preclude its use.

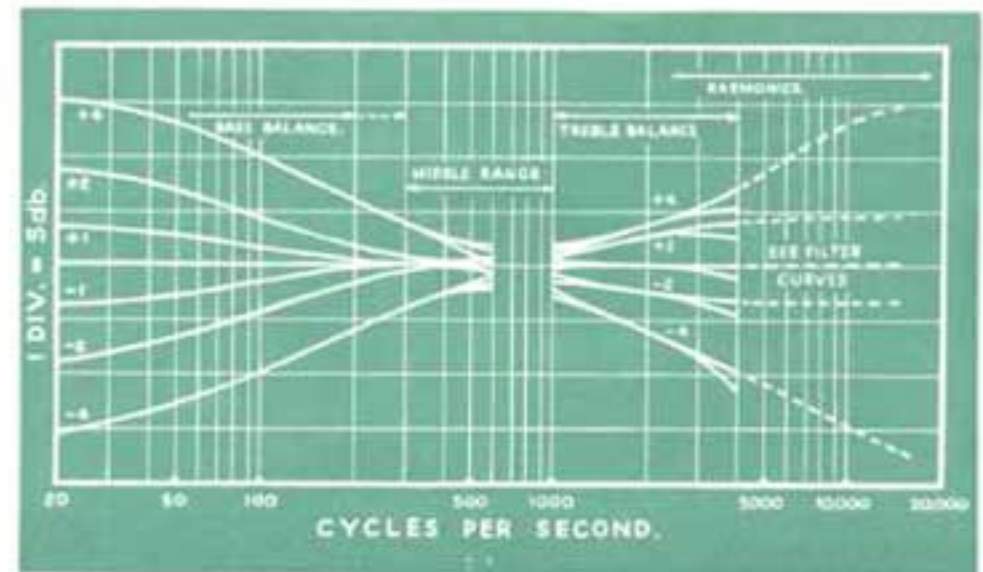
The control of slope operates from frequencies of 5Kc/s, 7Kc/s and 10Kc/s, these being equal musical intervals. The slope is continuously variable from level to 50 db/octave following the curves shown.

It will be seen that the slopes can be made to follow the

mirror image of distortion present in practical programmes. In this way, wide range with low distortion becomes possible. It should be emphasised that intensity of treble is entirely independently controlled since the filters modify the higher harmonics only and do not operate in the treble musical register.

ULTRA-SONIC FILTERING

In the level position, one of the inductors is coupled in a secondary circuit to provide a 20Kc/s low pass filter. In this way the response above 20Kc/s is always attenuated.



Curves showing slopes of response provided by the bass and treble controls. Adjustment is continuously variable.

The output of wide range pickups frequently contains components beyond the audio range the amplitude peaks of which exceed the peak amplitude within the audio range. Unless these are reduced they can cause unsuspected distortion or unnecessary limiting of available output power. For similar reasons, all circuits prior to

tone controls and filters will handle signal levels 15 db above that required for full output. In the 'cancel' position, bass, treble and filters, including the 20Kc/s filter, are out of circuit giving a level response (other than recording compensation if in use) from 20 c/s to 60 Kc/s. The coupling cable



Curves showing the range of the 7K filter continuously variable from level to 50 db/octave. The curve shapes are accurately maintained, the figures adjacent to the curves being the approximate dial settings. The 5K and 10K filters provide similar curves one half octave up or down. The 20 Kc/s filter is of course fixed.

Quality Control Unit

forms part of the circuit and should not be altered without consultation with the manufacturers.

STANDARD PLUG UNITS

Plug Unit type	Pickup input sensitivity	Maximum pickup impedance
*R.1 (or M.1)	8mV.	Magnetic pickups up to 2,000 ohms.
*R.2 (or M.2)	16mV.	Magnetic pickups up to 5,000 ohms or other types up to 50,000 ohms.
R.6 (or M.6)	3-6mV.	Moving coil pickups without transformer.
R.7 (or M.7)	6mV.	Ribbon types or other types up to 100,000 ohms.
R.10 (or M.10)	100mV.	High output magnetics and some crystal types.
R.12 (or M.12)	750mV.	Some crystal types.

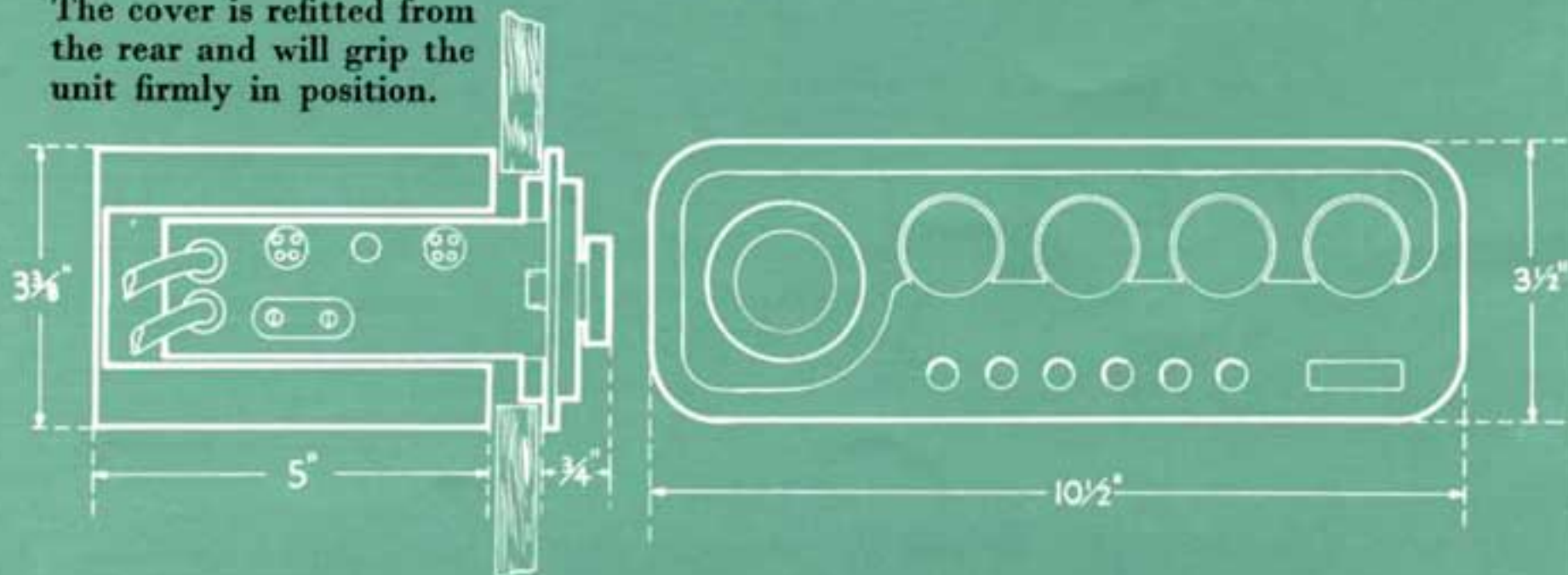
The above units R.1, R.2, etc., provide two independent radio inputs. For microphone and radio inputs the prefix M instead of R is used, e.g., M1, M.2, etc.

*Unit R.2 is supplied as standard with each control unit on U.K. models and R.1 as standard on U.S. models. Other units available as additional extras. See separate list showing plug units recommended for specific pickups.

Quality Control Unit

The Control unit may be fitted to cabinet panels of any thickness from $\frac{1}{8}$ " to $\frac{3}{4}$ ".

The cut-out required is shown on the right. The cover is removed and the unit inserted from the front when it will locate automatically. The cover is refitted from the rear and will grip the unit firmly in position.



Specification

Quality Control Unit

FREQUENCY RESPONSE :

Cancel position, Radio & Tape inputs : 20-20,000 c/s within 0.3db.
" " Microphone input : 20-18,000 c/s within 1db.
" " Pickup Input (R.2) Within 0.5db of stated characteristics. Other plugs, no significant change.

Bass and Treble controls : Within 1db of published curves.

Filter frequencies (ff) : 5Kc/s, 7Kc/s, 10Kc/s \pm 250 c/s.

Filter slope : Level to 50 db/Octave (see published curves).

INPUT SENSITIVITIES (for 1.4 V.rms output):

Radio and Tape : Internal impedance 100 K Ω : 100mV.

Microphone : " " 100 K Ω : 1.5mV.

Pickup : Depending upon plug unit—see table.

DISTORTION (1.4 V output):

All controls 'level', Radio input or R.2 pickup input: 0.02% approx.

Least favourable arrangement of plugs and controls : less than 0.1%

Permissible input overload for no significant increase Radio—immaterial, pickup see text.

VALVES : 1 x EF.86 (Z.729 or 6267), 1 x ECC.83 (12AX7) (ECC.81, B309 or 12AT7 with changed bias resistor).

POWER SUPPLY : The unit takes its power from the main amplifier.

330 V 2 mA } Plus currents taken by tuner units which may
6.3 V 1 A } be connected to sockets provided.

Maximum power available from tuner sockets :

330 V 30 mA (each tuner)

6.3 V 2.5 A (total) The heater supply is C.T. to chassis.

BACKGROUND :

— 70 db or where applicable, approximately 6 db above equivalent thermal noise of input impedance.

MECHANICAL :

Front panel : Die-cast, stove finished silvered fawn, machine engraved.

Knobs : Aluminium, stove matt brown, machine engraved.

Chassis and Cover : Steel, rust-proof processed, stove steel grey. The complete unit, electrically and mechanically is fully tropical and suitable for all climatic conditions.

DIMENSIONS : 10 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ ", see drawing.

WEIGHT : 7 lbs. nett. (3.15 Kg.)

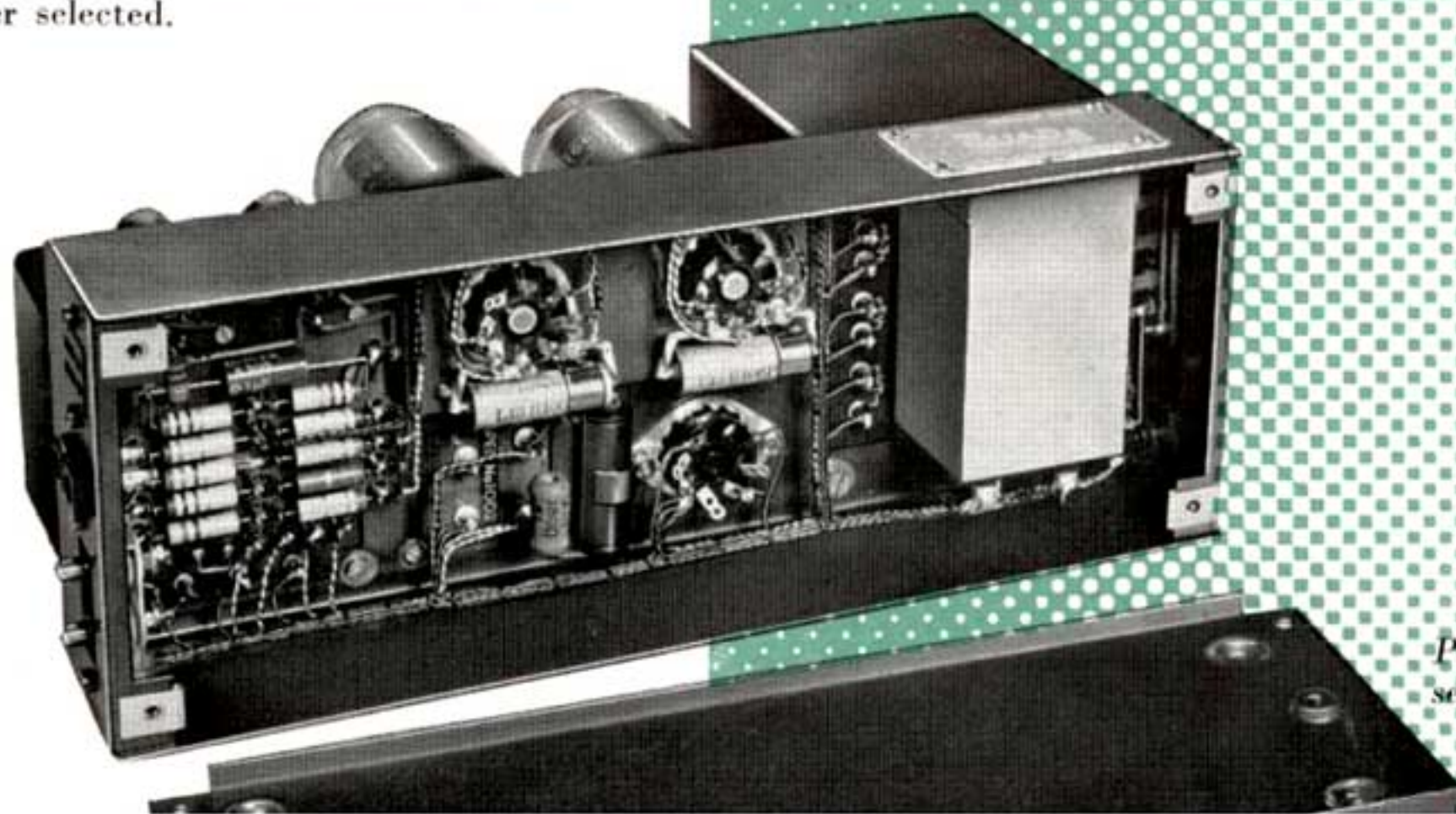
Quad II MAIN AMPLIFIER



The function of the main amplifier is that of amplifying the output from the control unit or other source with the highest possible standard of accuracy. This is achieved in the QUAD II to a degree unexcelled by any equipment known to be offered to the public. The amplifier is further unique in that this performance is obtained with stability which is complete. It is thus entirely independent of load or signal conditions, factors which are of the utmost importance in application. The specification is fully met with random valve replacement from standard commercially tested valves, without matching or alignment of any kind. Engineers will readily appreciate the high standards of reliability and specification constancy from the circuitry. Its design efficiency is apparent to all in terms of compactness and accessibility.

The amplifier is supplied as a self-contained independent unit for convenience of installation. Slightly smaller than its predecessor, it is ideally shaped for most applications—including that of rack mounting in the minimum space. It is fully tropical and is available for operation from all AC supplies. It is suitable for use with any loudspeaker(s), the quality of reproduction being solely that imposed by the limitation of the loudspeaker selected.

Quad II MAIN AMPLIFIER



Quad II MAIN AMPLIFIER

CIRCUIT DESCRIPTION

The QUAD II main amplifier differs from contemporary practice both in the output stage and in the penultimate stage contributing materially both to performance and efficiency in a manner that will delight the engineer.

THE OUTPUT STAGE

The basic principles utilised in the output stage design have been treated elsewhere* and need only brief reference here. It has been shown that by proportioning the influence of screen and anode currents on the load, a series of operating conditions may be obtained offering low distortion and high efficiency. Since cathode current is common to screen and anode, it is convenient to use cathode windings for reasons which have also been explained.*

The output stage as used in the QUAD II appears before feedback is applied as the equivalent push-pull triode

circuit as far as amplification and effective output impedance are concerned but with less than half the distortion and an increase of 40% in efficiency over the equivalent triode circuit. The screen and anode circuits are more favourably arranged for efficient smoothing, a factor which reflects itself in the overall size of the equipment.

THE OUTPUT TRANSFORMER

The output transformer employs five windings subdivided into fourteen sections ingeniously coupled so that the output stage phaseshift is extremely small within the range where the overall feedback loop gain exceeds unity. The small size of the output transformer resulting from optimum choice of flux and material should be noted. The distortion at 25 c/s at 12 watts output shows no significant increase over that at middle frequencies.

* *Wireless World*, Sept., '52.

THE PENULTIMATE STAGE

Full benefit can only be obtained from this output circuit if the feed is accurately balanced throughout the frequency range, since it is some three times more sensitive to unbalance than conventional operation. For reasons of phase, high stage gain is desirable and some form of see-saw circuit is called for. Such circuits, however, are grossly unsymmetrical in relation to the HT supply. In the QUAD II, two EF.86 valves are used, each feeding one output valve. The second EF.86 is fed from the first but with a signal 6 db lower than would be required for balance. The EF.86's are then coupled through their screens and cathodes so that they are always approaching balance. This arrangement is inherently stable, satisfies symmetry requirements and the balance error is automatically maintained through see-saw action. The output valve grid returns are applied to a fixed signal

Quad II MAIN AMPLIFIER

point in phase with one and out of phase with the other, the small signal so applied being equal to the small resultant balance error previously mentioned. In this way, the complete phase change centres around perfect balance and provided the anode load resistors are of equal value, the error with random valve selection is considerably better than 1%.

Quad II MAIN AMPLIFIER

FEEDBACK AND LINEARITY

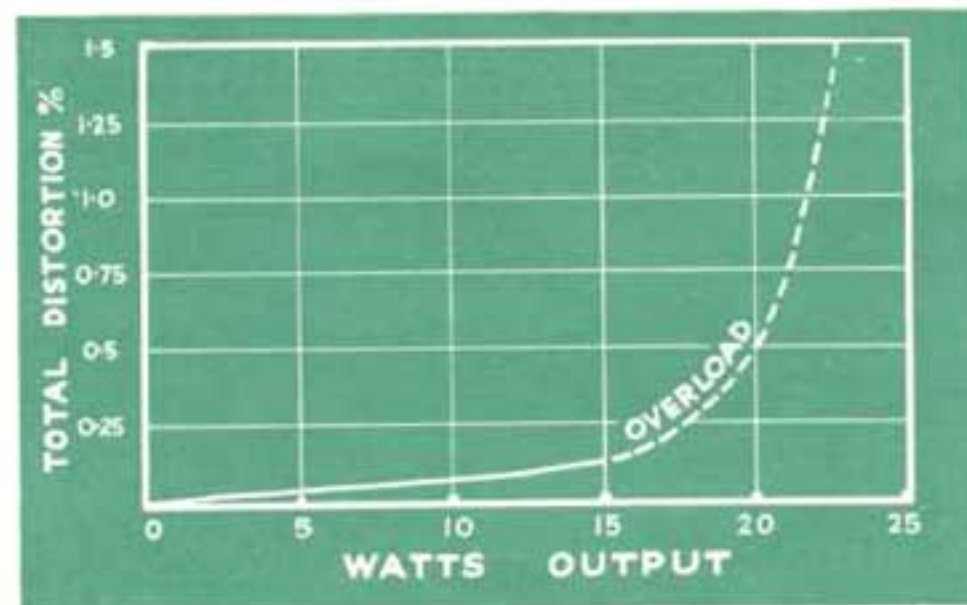
The overall feedback is an integral part of the amplifier design and cannot be considered separately.

The standard of pass figures for distortion is, of course, well below audibility no matter how refined the test. They are given in full because only in this way do they give a proper indication that the circuitry is operating exactly as intended and not by part cancellation of distortion from one stage to another by fortunate valve selection.

PERFORMANCE ADVANTAGES

The complete circuit shows a number of performance advantages over contemporary equipment. Stability is complete and *entirely independent of the load*. Low distortion is not dependent on 'matched' valves and the figures given cover the *whole tolerance of commercial*

valve manufacturers tests. The frequency response is completely free from 'ears.' The input is not prone to embarrassment by the presence of frequencies outside the audio range. The importance of these features in terms of performance and the holding of that performance through service is obvious. The efficiency of the circuit provides a high tolerance of reliability due to the fact that all valves are operating well below maximum dissipation and the HT supply does not exceed 340 volts.



Linearity and overload of the QUAD II amplifier

Specification

Figures for response, distortion, sensitivity and background are the pass figures on final test.

Quad II MAIN AMPLIFIER

POWER OUTPUT :

15 watts throughout the range 20—20,000 c/s.

FREQUENCY RESPONSE :

Within 0.2 db 20—20,000 c/s.

Within 0.5 db 10—50,000 c/s.

DISTORTION (measured at 12 watts output) :

Total 3rd and higher order : less than 0.1% at 700 c/s.

Higher order alone : less than 0.03% at 700 c/s.

Valve mismatching up to 25% (introducing 2nd harmonic) not to cause distortion to exceed 0.18%.

Total distortion at 25 c/s not to exceed 0.25%.

INPUT :

Sensitivity : 1.4 V. rms for 15 watts output.

Load imposed on input : 1.5 M Ω in parallel with 10 μ F

BACKGROUND : —80 db referred to 15 watts.

OUTPUT IMPEDANCES : 15 Ω and 7 Ω

Effective output resistance : 1 Ω for 15 Ω output.

POWER SUPPLIES :

INPUT : 200–250 A.C. single phase (or 100–130 A.C.).
40–80 c/s.

80 watts consumption (excl. control unit, tuners, etc.)

HT AND LT supplies available for external equipment:
330 V. 40 mA.

6.3 V. 3.5 A. (heater C.T. to chassis).

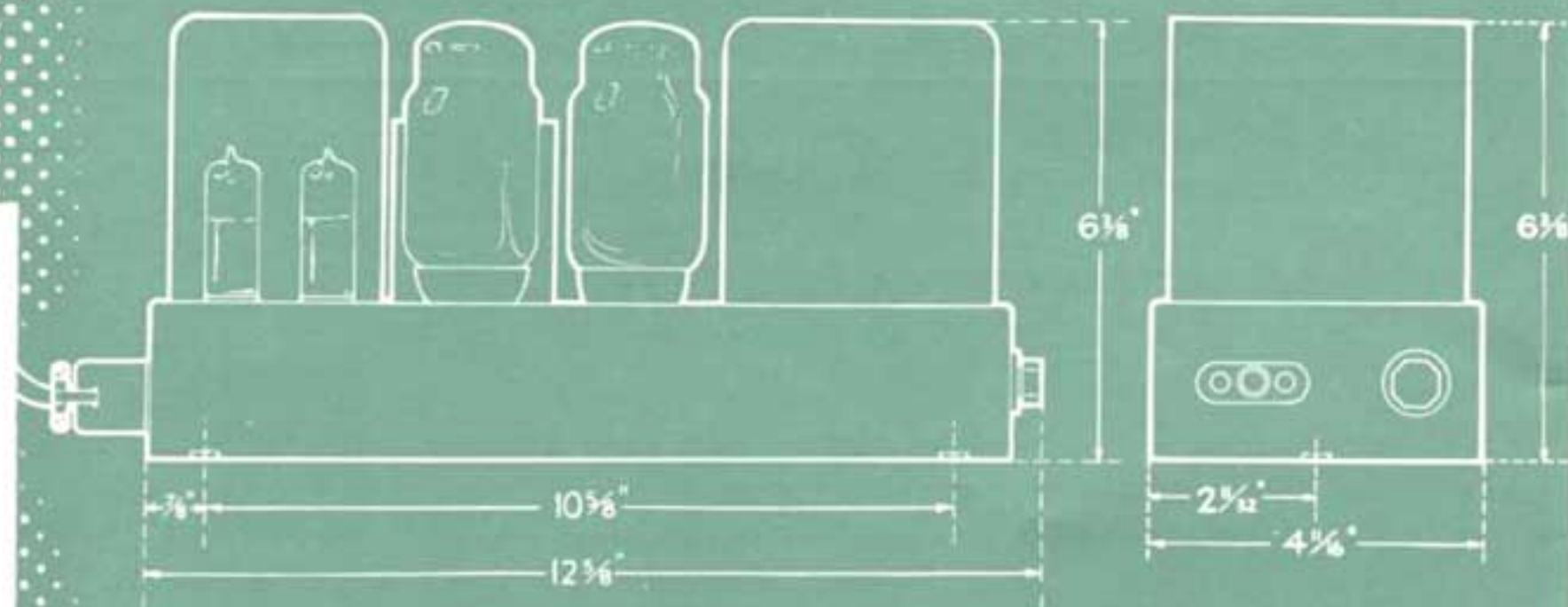
VALVES : 2 x EF.86 (Z.729 or 6267), 2 x KT.66
(5883 or 6L6G matched), 1 x GZ.32 (54KU.
or 5V4G.).

WEIGHT : 18½ lbs. (8.3 Kg.)

DIMENSIONS : 13" x 4¾" x 6½". See drawing.

MECHANICAL : All windings impregnated and housed in compound filled casings. All metal work fully rust-proof processed and stoved steel grey. Metal work, rust-proofing, finishing, transformer winding, tropicalisation, assembly and tests, all carried out under constant supervision by our AID approved inspection section. The equipment is suitable for use under all climatic conditions.

Quad II MAIN AMPLIFIER



The QUAD main amplifier dimensions are given above. In fitting in a cabinet, 2" either end should be allowed for easy access to the fuse and input and output leads. It may be fixed in position by means of the two tapped holds in the baseplate.

Guarantee

This instrument is guaranteed against any defect in material or workmanship for a period of twelve months from the date of purchase. We undertake to replace within this period, free of charge, such parts (excepting valves which are covered by the Manufacturer's Guarantee of three months) as may prove on examination to be defective provided that the instrument was purchased at our full current retail price.

