

# The Williamson Amplifier

In the first of a new series, we take classic kit from yesteryear and see how it measures up against today's best. We kick off with the granddaddy of all hi-fi amplifiers...  
 Review: **John Howes & Ken Kessler** Lab: **Paul Miller**

If one product had more influence on the direction taken by the early hi-fi industry than any other it was the Williamson amplifier. Its design, published in the April and May 1947 issues of *Wireless World* magazine, was to become a landmark. The articles, which not only described the circuit but gave details on how to build it, were an instant success, appealing to enthusiasts and home constructors alike. Later the design would go on to become a very successful commercial product, selling in large numbers across the world.

David Theodore Nelson Williamson was born in Edinburgh in 1923 and went on to study mechanical and electrical engineering at the University of Edinburgh. In 1943 he started work as an engineer in the development laboratory of Marconi Osram (MO). He soon moved to the applications laboratory, writing up notes after testing new valve designs and circuitry. Williamson was interested in high quality sound reproduction and in his spare time worked on amplifier design and a lightweight pick-up. His hard work came to fruition in an amplifier with very low harmonic distortion: less than 0.1%, in fact.

**'Williamson did not gain financially from the *WW* article'**

Williamson was asked to demonstrate his amplifier to the MO valve company board and to write a report on it. After Williamson left MO in 1946 to join Ferranti, a director of parent company GEC took the report to the editor of *Wireless World*, and it was duly published.

Williamson did not gain financially from the *Wireless World* article but found

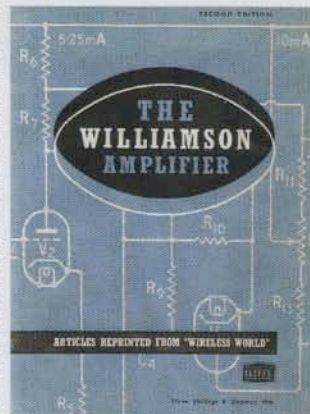
instant fame worldwide. Indeed, it was Osram which profited handsomely as Williamson had specified Osram valves in his design, so creating a huge demand for that company's tubes. Likewise, the publication in 1949 of the 'Williamson Amplifier' booklet must have seen many hundreds of thousands of KT66 tetrode valves sold worldwide while transformer manufacturers like Partridge [see Retro Roundup, *HFN* August '09], Woden, Gardners, Gilson and Savage must also have benefitted greatly.

## THE PERFECT AMP...

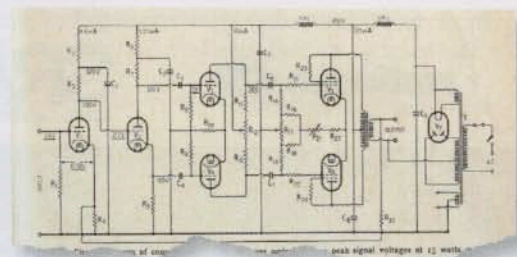
The original *Wireless World* article outlined seven basic requirements for a perfect amplifier. These were negligible non-linear distortion, a linear frequency response from 10Hz-20kHz, a constant power

handling capacity for negligible non-linear distortion at any frequency within the audible frequency spectrum, negligible phase shift over the same bandwidth, good transient response, low output resistance, and adequate power reserve. As for the Williamson amplifier specification, this was a maximum power output of 15W, a frequency response of 10Hz-20kHz  $\pm 0.2$ dB, background noise of  $-85$ dB below maximum output and an input sensitivity for maximum output that was 1.4Vrms.

The output transformer was given paramount importance. To quote from the original text: 'The output transformer is probably the most critical component in a high fidelity amplifier'. Detailed electrical and mechanical specifications of the output transformer were given in Williamson's article and many keen home



**ABOVE:** The Williamson Amplifier circuit, reprinted from *Wireless World* and offered separately for sale at a cost of 3s/6d; ad for GW18/C amp from Goodsell of Brighton; GEC promotes Osram valves



**ABOVE:** Circuit design of the complete amplifier, as published in *Wireless World*; voltages underlined are peak signal voltages



**ABOVE:** Ad for Partridge transformers; like many companies, Partridge benefitted from the popularity of the DIY Williamson amp kit





constructors wound their own. For those curious to know, the design specification of the output transformer is as follows: primary load impedance 10,000ohms, centre tapped; secondary load impedance 1.7ohms per section with a turns ratio of 76:1; primary inductance 100Henries (minimum), leakage inductance 30milliHenries (maximum).

The cost of a commercially made Williamson output transformer in 1949 was six guineas. The mains transformer cost four guineas while smoothing chokes would set you back a pound apiece. Complete kits were offered for sale in the UK by Stern and Tele-Radio and cost between 19 and 21 guineas, depending on the transformers supplied. Many commercially made Williamson amplifiers were manufactured by Radford, Rogers, Goodsell, Cape and Heathkit – to name but a few.

In America the Williamson design gained huge success with an article in the November 1949 issue of *Audio Engineering*. Entitled the 'Musician's

Amplifier', this used American 807 output valves instead of KT66s in the output stage. Many companies in America sold kits to construct the 'Musician's amplifier' utilising two separate chassis.

A further article appeared in the July 1952 issue of *Audio Engineering*. Written by David Hafler and Herbert Keroes, the article outlined circuit modifications,

## 'Partnered with efficient speakers, sound quality is superb'

including changing the values of the coupling capacitors and using an output transformer with ultra linear connections. These modifications gave an increase in output power without sacrificing its specifications. In this article a choice of three different output valves were given: 807s, 5881s or KT66s.

Williamson stayed at Ferranti until 1960, after which he moved to the Molins Machine Company. In 1973 he worked for, and then joined, Rank Xerox, where he stayed until 1976. During his life he lodged over 100 patent applications concerned with machine tools and cigarette machinery, as sole or joint inventor.

In 1979 the Williamson family moved to Italy. David Williamson passed away on the May 10th, 1992.

## SHOOT-OUT

I have been lucky enough to own and build several Williamson amps over the past 40 years. Partnered with efficient speakers, sound quality is superb.

**LEFT:** Suggested circuit mods from 1952 and 1949 issues of *Audio Engineering*

**ABOVE:** Our Williamson amplifier, equipped with four 6J5 triodes, a 53KU rectifier tube, pair of KT66 tetrodes and Partridge transformers

About six months ago I organised an amplifier 'shoot out' at my home with some of my audio enthusiast friends. This saw The Williamson in a blind test against a very respected Japanese single-ended triode design and a single-ended pentode amplifier. We played different types of music through each amp in turn, nine listeners (excluding myself) voting individually on sound quality.

Scoring was close, but the Williamson won, followed by the single-ended triode design. What amazed me was the fact that a 62-year-old design eclipsed some very serious modern contenders. Call me a fan!

## KEN KESSLER LISTENS...

Analogies fail me, for no precise illustrations mirror the historical importance of this amplifier nor its

**NEW WILLIAMSON TYPE**  
*Heathkit*  
**AMPLIFIER KIT**

**FEATURES**

- Positive feedback: Because of intermodulation distortion, the Williamson kit has a gain of 15, not 20.
- Improved coupling: A 500K resistor in the 500K coupling capacitor PTH1012 in A10200000 components analysis.
- 100% Williamson kit amplifier: Includes a matching transformer.

When selecting an amplifier for the best of its kind, the Heathkit Williamson kit is the only one that offers the following advantages:

- A choice of three different output valves: 807, 5881, or KT66.
- A choice of three different output transformer ratios: 1:1, 1:2, or 1:4.
- A choice of three different speaker impedances: 16Ω, 8Ω, or 4Ω.
- A choice of three different speaker sizes: 6", 8", or 10".
- A choice of three different speaker types: Paper, Alnico, or Ceramic.
- A choice of three different speaker brands: JBL, Altec, or Partridge.
- A choice of three different speaker models: A, B, or C.
- A choice of three different speaker prices: \$149.95, \$199.95, or \$249.95.
- A choice of three different speaker options: Standard, Deluxe, or Professional.
- A choice of three different speaker finishes: Black, Silver, or Gold.
- A choice of three different speaker materials: Steel, Aluminum, or Brass.
- A choice of three different speaker weights: 10 lbs, 15 lbs, or 20 lbs.
- A choice of three different speaker heights: 10", 12", or 14".
- A choice of three different speaker widths: 10", 12", or 14".
- A choice of three different speaker depths: 10", 12", or 14".
- A choice of three different speaker volumes: 10, 15, or 20.
- A choice of three different speaker frequencies: 10, 15, or 20.
- A choice of three different speaker phases: 10, 15, or 20.
- A choice of three different speaker impedances: 10, 15, or 20.
- A choice of three different speaker reactances: 10, 15, or 20.
- A choice of three different speaker inductances: 10, 15, or 20.
- A choice of three different speaker capacitances: 10, 15, or 20.
- A choice of three different speaker conductances: 10, 15, or 20.
- A choice of three different speaker susceptances: 10, 15, or 20.
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**HEATH COMPANY**  
BENTON HARBOR 25, MICH.

**ABOVE:** Original advert for 'Williamson Type' amplifier construction kit from Heathkit with instruction manual to suit 'the complete novice'

**Ultra-Linear Operation of the Williamson Amplifier**  
DAVID HAFLER and HERBERT KEROES

**Musician's Amplifier**  
DAVID HAFLER and HERBERT KEROES

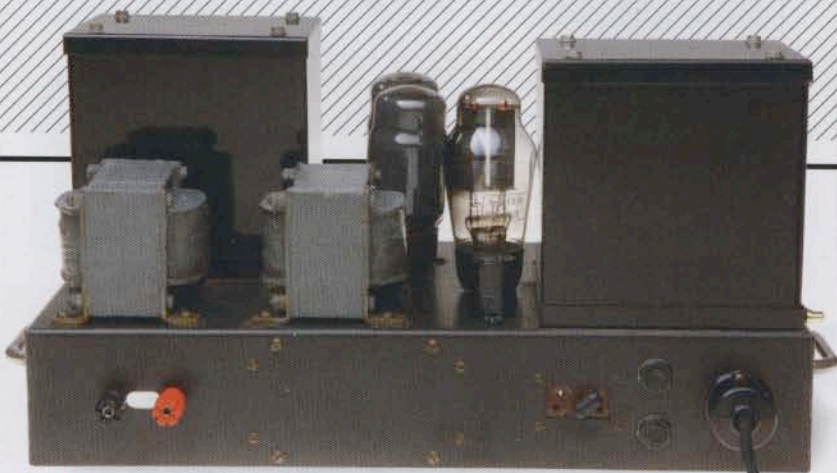


## LAB REPORT

### WILLIAMSON AMP (VINTAGE)

What a remarkable amplifier! Sure enough, there is some slight variation in overall gain (between +14.7dB and +15.1dB) depending on operating temperature and power history, but this Williamson's underlying performance is more than a match for some 'new' valve amplifiers that have crossed my lab bench in recent years. The estimated 15W specification was largely met in practice with 14.3W/8ohm and 10.4W/4ohm achieved at 2% distortion, increasing to 15W/8ohm at 4.5%. There's little dynamic headroom, nevertheless the vintage GEC KT66 beam tetrodes robustly deliver some 6W/2ohm and 3W/1ohm via single transformer tap at 1kHz [see Graph 1, below]. It goes without saying that sensitive speakers are a must.

Distortion is largely 2nd and 3rd harmonic in nature and reaches a low of 0.008% through the midrange at 1W/8ohm. Distortion otherwise hovers between 0.1-0.2% up to 6W/8ohm and <1% below 11W/8ohm, increasing to 0.4-0.5% at bass (20Hz) and treble (20kHz) frequencies. Core saturation in the Partridge output transformer causes distortion to rise quickly at subsonic frequencies [see Graph 2, below] but the low 0.2ohm source impedance is remarkably flat across the audio range. Furthermore, the amplifier's response is both flatter and better extended than many modern designs, peaking at +0.6dB/55kHz into 8ohm and +0.5dB/48kHz into 4ohm loads while stretching down to +0.25dB at a subsonic 5Hz (all figures re. 0dB/1kHz). This is a true heavyweight of the vintage class. Readers are invited to view a comprehensive QC Suite test report for this Williamson-inspired amp by navigating to [www.hifinews.co.uk](http://www.hifinews.co.uk) and clicking on the red 'download' button. **PM**



**ABOVE:** The Partridge o/p transformer's 8ohm secondary tap is terminated here in a pair of 4mm speaker posts. Note the three-pin Bulgin-style mains plug!

performance, which still dazzles listeners more than 60 years on. I suppose the initial exposure to a Williamson could be likened to a first drive of a Bugatti Type 35B, or a first sip of Romanée-Conti. Yes, it's in that league.

Appropriately, I auditioned it in mono – no hardship as I adore a number of single-channel recordings. I was warned about low sensitivity, but given free reign with the speakers I used. It sang from the outset, robust and warm and dynamically thrilling, yet with a rosy hue that belied not its age but its heart: pure thermionic valve. Voices benefitted most, exhibiting palpability and authenticity with Doris Day's vocals from the *Love Me Or Leave Me* soundtrack of 1955. The little vocal tics that made her a far more distinctive singer than cloth-eared critics would ever admit shone through; she simply sparkled.

Silk-against-velvet slid from the speakers when I fed it Julie

London's debut LP. Transients met CD's demands when I dug into The Beatles remasters. The Williamson transcended years, formats, recording techniques. It delivered what it was fed, tampering with nothing, interceding between music and listener with only the most gossamer of veils.

#### A NEW REFERENCE

But a burning question remains: is this antique up to the rigours of 2010? Put it this way: if *any* valve amp maker had the guts to reissue this exactly according to Williamson's design, with valves worthy of the

*'The burning question: is this antique up to the rigours of 2010?'*

circuit and the best transformers Partridge could muster, the result would be a new global reference. Address the details needed to get it past CE requirements, create modern cosmetics and a price of around £5000 per pair – the R&D has been paid for, right? – and the effect would be revolutionary. ☺

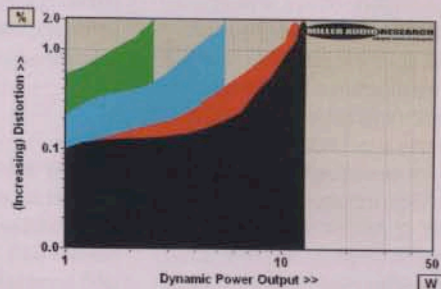
#### HI-FI NEWS VERDICT

Introduced before the vinyl LP and over a decade before stereo, the Williamson amplifier circuit marched in the front rank of high fidelity's vanguard. Over 60 years later its performance still bears favourable comparison with specialised tube amps produced in our modern era, so there's no reason why the Williamson couldn't form the template for new models. The real question is which manufacturer will pick up the gauntlet?

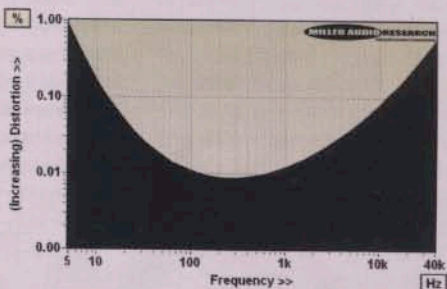
Sound Quality: 80%



**ABOVE:** Partridge's superlative CFB C-core output transformer was the 'high-end' choice for amps of the day



**ABOVE:** Dynamic power output versus distortion into 8ohm (black trace), 4ohm (red), 2ohm (blue) and 1ohm (green) speaker loads



**ABOVE:** Distortion vs. extended frequency from 5Hz to 40kHz (1W/8ohm). Distortion increases rapidly at the frequency extremes at just 5W/8ohm output

#### HI-FI NEWS SPECIFICATIONS

Power output (<1% THD, 8/4ohm)	14W / 10W
Dynamic power (<1% THD, 8/4/2/1ohm)	13W / 13W / 5.5W / 2.6W
Output impedance (20Hz–20kHz)	0.18–0.23ohm
Frequency response (20Hz–100kHz)	+0.0dB to –2.6dB
Input sensitivity (for 0dBW/15W)	497mV / 1970mV
A-wtd S/N ratio (re. 0dBW/15W)	89.0dB / 100.8dB
Distortion (20Hz–20kHz, 5W)	0.068–0.46%
Power consumption (idle/Rated o/p)	135W/128W
Dimensions (WHD)	Determined by host chassis