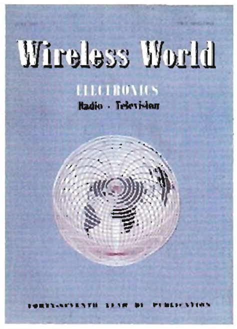
The Twin-Triode Transistor – the First Integrated Circuit?

by Stef Niewiadomski



At the Royal Wootton Bassett BVWS meeting in December 2011 I bought a full set of 1957 Wireless Worlds for a very reasonable price. The magazines are packed full of vintage articles and adverts (which I think often tell us more about the times than the articles), and if you can find space to store them – Wireless Worlds are very bulky – they are a very useful source of historic data.

A brief feature in the July 1957 issue entitled 'Twin-Triode Transistor' caught my eye, reproduced in full in the accompanying diagram. As you can see General Electric in the US had recently announced a twin-triode transistor, targeted at the frequency changer, IF amplifiers and audio stage of consumer transistor radios. It's not clear from the article whether the transistor, and the radio it was meant to be used in, was actually built. The original source of the information was the April 1957 issue of Electronics magazine. I presume there is nothing ominous about the April date, and I'm sure Wireless World would not have picked up the announcement had there been any doubt as to its truthfulness.

The winter 2011 BVWS Bulletin article 'The Emerson 868 Miracle Wand 4 Transistor Receiver' shows a typical 1957 design, optimised to keep the number of (expensive) transistors down to four, plus a diode. GE were a big manufacturer of radios, including transistor-based ones, at the time and their own sets were presumably the target for this new type of transistor.

The device had four junctions, producing two NPN transistors, and was described as a tetra-junction transistor, so I suppose if allocated an RMA code, it would have had a 4Nxx part number. It strikes me that since there are two active devices on a single piece of semiconductor material – germanium of course – does this qualify as an Integrated Circuit? The common understanding of an IC is that it's a planar device, with active transistors, diodes and resistors deposited across its surface, and interconnected using metal, though I'm not sure if this is too restrictive a definition?

Jack Kilby at Texas Instruments is generally credited with inventing the IC, the first germanium part fabricated in September 1958. Robert Noyce at Fairchild was working on the same idea at the same time and produced the first IC on silicon. After several years of legal battles the two companies eventually agreed to cross-license their technologies. If built it seems to me that the GE tetra-junction transistor pre-dates TI's and Fairchild's introduction of the IC.

US Patent 3,138,743 for 'Miniaturized Electronic Circuits', the first integrated circuit, was filed on February 6, 1959. In the patent application Kilby described his new device as 'a body of semiconductor material ... wherein all the components of the electronic circuit are completely integrated'. At the time this was an optimistic (and all-encompassing – a key feature of a successful and long-lived patent) view of what could be achieved. Early ICs typically integrated only the transistors of the circuit and many external components, for example the capacitors and any resistors that needed to have precise values, were still needed.

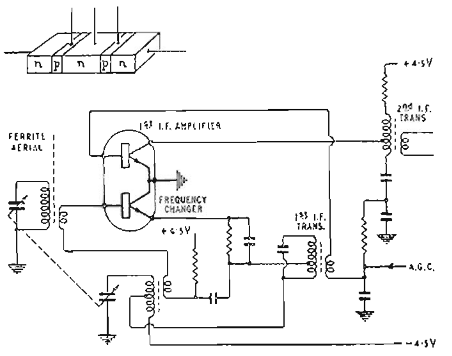
Does anyone have more information on this GE device? Was it ever made? Were any radios built using the device?

http://www.pat2pdf.org/ is a good patent website where you can download pdf versions of many original patents, including the key IC patents of Kilby (3,138,743) and Noyce (2,981,877).

Technical Notebook

New Microwave Ferrites with the desirable properties of controllable saturation magnetization, low dielectric loss, and high degree of reproducibility have been developed by L. G. Van Uitert, of Bell Telephone Laboratories. As already described in *Wireless World*, ferrite components inserted into waveguides can perform quite complex circuit functions by utilizing ferromagnetic resonance and other phenomena (see December, 1956, issue, p. 595). The new materials are essentially magnesium, manganese, aluminium ferrites or nickel manganese ferrite with a small amount of copper replacing some of the magnesium or nickel. The addition of the proper quantities of copper and manganese to the basic ferrite is advantageous from several points of view. By increasing the reactivity of the mixture, copper decreases the necessary firing temperature by at least 100°C. Under comparable conditions this results in lower porosity and improved uniformity in the fired matetial. The manganese addition decreases electrical conductivity and hence the dielectric losses in these low porosity materials. Microwave ferrites with low saturation magnetizations are obtained by the modification of magnesium ferrite. The saturation magnetization of this ferrite can be decreased in a controlled way by substituting aluminium for a part of the iron. While materials compounded in this fashion are basically satisfactory, their refractory nature makes it difficult to reproduce the magnetic properties required for many microwave applications. The added copper minimizes this difficulty, and also increases slightly the Curie temperature for comparable saturation magnetization.

Twin-Triode Transistor consisting of two n-p-n units, with a common piece of germanium forming the emitter of one and the collector of the other, has been developed by General Electric in the U.S.A. The structure is shown at the top left of the illustration, while the graphical symbol appears in the circuit below. The idea is, of course, to reduce the cost of transistor sound broadcast receivers, and a set using two of the tetra-junction units in place of four ordinary transistors was described in the April, 1957, issue of *Electronics*. The "front end" of the circuit, as shown, uses a tetra-junction transistor to provide an autodyne frequency changer and an i.f. amplifier. Since the two structures are in series, twice the normal supply voltage is required and the receiver uses two 4.5-V batteries in series with their centre point earthed. As the common element of the tetra-junction transistor is earthed the two sections function independently, the top half as a common-emitter earthed-emitter stage and the lower half as a common-emitter earthed-collector stage. The other tetra-junction transistor in the set is used as a combined second i.f. stage and audio driver stage.



Metal-screen Circuit Printing of high accuracy and consistency was recently demonstrated by Gordon & Gotch on a new German screen printing machine specially designed for this type of work. Screen printing with a stencil is a very simple and convenient method of laying a heavy deposit of acid-resistant ink on the copper to be etched, but when the traditional silk screen is used the accuracy of registration is not very high. The new machine, however, uses a metal gauze screen with a metal stencil bonded to it, made by The Royal Mint Refinery. This is stretched over a frame and tightened by means of an inflatable tube round the edges—a system by which the applied tension is equalized all round to give very even stretching. Apart from its dimensional stability, the metal screen stretched in this way has the advantage of greater elasticity

than the normal silk screen when the ink is being pressed through it with the squeegee. This means that the screen springs away from the work immediately after the squeegee has passed on, and there is no time for the ink to drift and slur away from the required pattern. Stainless steel or bronze (which is cheaper) can be used for the screens. While printing is taking place the work is held completely flat on the bed of the machine by a powerful air suction system. Gordon & Gotch are the sole agents in the U.K. and Ireland for the machine, which is made by Siebdruckgeräte von Holzschuher.

Industrial Linear Accelerator has been built by Mullard for giving high-energy X-rays for radiographic examination of large metal specimens. Despite its high energy of 5 MeV, and the large X-ray output of over 500 roentgens per minute at 1 metre, the electron beam has a diameter of only 2mm when it strikes the target. Moreover, the polar diagram of the

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