October 2007

Issue #22

This newsletter is sent out to all who have called in on the AWA net with the hopes that it will encourage you to call in again and help to keep the AWA net alive and well.

Should you not want to receive any further publications of this newsletter, drop me a note and I will take you off the mailing list.

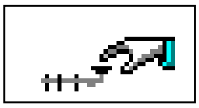
Happenings:

Once again things have been fairly quiet this month with no unusual happenings. We still seem to be plagued with poor band conditions due to low sunspot activity, but also still get regular calls on the 40m and 80m bands on Saturday mornings.

Saturday morning AM and SSB nets still seem to average around 15 – 20 calling in on the net, which I suppose is not too bad, but we do look forward to the day when band conditions will start to improve. It certainly has been a long time coming.

The 80m relay has proved to be quite successful with fairly good reports coming in from those who listen in and we want to encourage the local stations, ZS6, to use the 80m band as it does give satisfactory results. The Div 5 stations find that when 40m is out to div 6, they can still work quite well in to div 6 on 80m. If you don't have an 80m antenna up by now, then it may be a good time to get one in the air.

I sent out a request to all those on the email system about the prospects of the AWA running a QSO party utilizing valve rigs. I have a few replies with some very good suggestions, which I will pass on to the committee members to have a look at. Of the replies I have had so far, all are in favour of it. The end of October is the closing date for us to get an application in to the contest committee to be listed in the contest manual.

ZS0AWA/CW. 

Heard on frequency this last month has been Barrie ZS6AJY, Ian ZS5IAN, John ZS5JON & Pierre ZS6BQS. Join us on Saturday afternoons at 14:00 SAST. The net is run at ±12 wpm and so should meet the needs of all interested in CW. 7020 is the frequency.

Ian, ZS5IAN, has started running CW in the evenings on 80m – 3579 and/or 40m 7020 from 19:30. Just a casual get together for those wanting to have a rag chew on CW. Look out for that one.

AM Net:

The Wednesday evening net has really been an up and down story with band conditions varying from 5/9 signals to absolute silence. I must admit though, the times when the band is good we have been able to take advantage of it, because we have been there. If you don't switch on and try, you'll never know what's happening.

Please come up and join us if you have the time and the inclination. On Wednesday some of the guys start transmitting on AM from 17:00 in the evening, so log in when you can. Saturday mornings from 06:00 on 3615.

Heard on frequency this month have been Gary ZS5NK, Rod ZS5RK, Don ZS5DR, Munro ZS5IN, Rad ZS6RAD, Barney ZS6BLL, Willem ZS6ALL, Denis ZR6DNS, Brian ZS2AB and yours truly ZS6ADY. Time we had some newcomers joining us. If you just listen in to the AM net then send us a signal report and let us know how reception has been. You can either email or send an sms to 082 448 4368.

SSB Net:

With 40m remaining a difficult prospect for local as well as div 5 stations, the 80m relay is proving to be quite popular. However, there are times that I will not be available to do the relay and wonder if there is anyone else who has the capability to do a relay from 40m to 80m and vise versa. The main thing is not just to have 2 HF rigs, but to have 2 separate antenna's, preferably in opposing directions. In other words one north/south and the other east west, if mounted close to each other. If you are able to assist with this, please contact Andy either by email or by phone on 082 448 4368.

We appeal to all of you, when calling in on 40m, should you not be able to hear the control station, try letting someone know who you can hear and you know can hear the control station. It's better than doubling over everybody. Better still, try 80m.

I also am aware of a few people who are getting in to some serious rebuilds, so let us have some articles and photo's of your labours of love.

THE TUBE IS DEAD. LONG LIVE THE TUBE

THE VACUUM TUBE HAS BEEN OBSOLETE FOR DECADES—AND IT'S HERE TO STAY
BY MARK WOLVERTON

IT'S 1960 OR SO, AND YOU'RE A 12-YEAR-old living in a suburb somewhere on the East Coast. It's late on a school night and you're in bed, but you're not sleeping; you're listening to a big old Atwater Kent radio that you inherited when your mother got one of those new transistor radios for the kitchen. Tonight you're tuned to WOR in New York at 710 AM, and you're listening to this guy named Jean Shepherd who's telling a funny story about when he was a kid and blew up his ham radio one day, scaring his mother and almost burning down the house. Then he starts talking about radio and vacuum tubes, and he says that those new things called transistors may be good for some stuff, but they'll never replace tubes altogether: "When you get down to putting out 50,000 watts of radio frequency, no sir. You gotta call in the big boys with the fans blowing on 'em. With the water running through 'em to keep 'em cool."

Then you look over at the nightstand, and see the orange glow behind the Atwater Kent giving the only light in the room, and even under the sheets you can feel the reassuring warmth of the radio's tubes, and you know Shepherd is right. Your mom's new transistor set doesn't sound nearly as good as the Atwater Kent, or a real hi-fi with tubes. How could some dinky little gadget that doesn't even light up replace all that?

What you didn't know at the time, of course, was that the writing was already on the wall. Even while the vacuum tube was still the undisputed king of the electronics world, in the 1950s and early 1960s, engineers were diligently experimenting, learning how to build solid-state circuits with the recently invented transistor. As the six-ties dissolved into the seventies, transistors and integrated circuits pushed tubes aside in all sorts of consumer electronics, from stereo systems to radios to television sets, until by 1980 you would be hard pressed to find a tube in any device in your home—except for the single, huge picture tube in the TV. Yet the vacuum tube remains on the scene, stubbornly hanging on almost a century after its invention. Is this mere nostalgia? Perhaps, or at least in part. But nostalgia or not, there are still some jobs for which the obsolete vacuum tube is the better choice.

Like so many other inventions, the vacuum tube can be traced back to Thomas Edison. In a sense Edison invented the very first tube, one that you use every day, the ordinary light bulb. In electronics, however, the term *vacuum tube* (also called, in the United Kingdom, a valve) describes a device that controls the flow of electrons through a vacuum. Edison discovered in 1883 that if he placed another electrode, in addition to the filament, inside one of his light bulbs, electricity would mysteriously flow through the vacuum from the filament to that second electrode. With an uncharacteristic lack of foresight that he later regretted, he found the phenomenon interesting but useless, and he did no more than make it be known as the "Edison effect."

The Edison effect remained nothing but an oddity until the British scientist John Ambrose Fleming began experimenting with it early in the twentieth century. By 1904 he had developed the Fleming diode, which used the Edison effect in a vacuum tube containing two electrodes, called the cathode (or filament) and the anode (or plate). Applying electricity to the cathode, heating it, caused current to flow to the anode. Because only the hot cathode, and not the cool anode, gave off electrons, current could flow in only one direction. Fleming had invented a rectifier, a device to convert alternating current into direct current. The Fleming diode found immediate application in the detection of weak radiotelegraph signals.

USEFUL AS IT WAS, HOWEVER, Fleming's diode could only pick up signals, not amplify them. That came soon after, when the American engineer Lee de Forest inserted a third electrode between the cathode and anode, thus creating a "triode." When applying a current to this third electrode, called a grid, de Forest discovered that he had created the world's first device capable of actually amplifying a signal. He patented his Audion tube in 1907, giving birth to the science of electronics. In the following decades thousands of tube types were devised for radio, radar, television, and audio: tetrodes (with two grids between the cathode and anode), pentodes (three grids), and various other multiple-grid designs. All were variations of de Forest's basic Audion concept.

Despite the great ingenuity of their designs, though, tubes had problems. They were fragile. Drop one and break its glass envelope, and just like a light bulb, it was dead. They were expensive to manufacture, because of the difficulty of achieving a sufficient vacuum. Tube equipment was physically bulky and heavy. Tubes needed big, heavy transformers to manage the high voltages they required, and the transformers not only could be unwieldy and expensive but also could affect the signals the devices handled. Most troublesome was the heat problem. By their very nature, vacuum tubes reach temperatures of hundreds or even thousands of degrees. Pack a lot of them into a small space, and the resulting heat can adversely affect other components and pose a hazard for anyone who happens to touch the equipment in the wrong place. Finally, tubes have a finite lifespan. Inevitably they burn out and need replacement.

Spurred by the need for an alternative, and building on the electronics developments of World War II and discoveries in solid-state physics, William Shockley, John Bardeen, and Walter Brattain, at Bell Labs, developed the transistor in 1947 and 1948. Transistors could do the same jobs as vacuum tubes, rectifying or amplifying current, but were much smaller and lighter, needed far less power, and promised greater reliability and versatility.

Still, the vacuum tube wasn't going to go away easily. In fact, tube technology probably reached its highest level of sophistication during the 1950s. Television sets were beginning to invade the American home, and every one was built with tubes. The golden age of hi-fi started around 1953, with elegantly designed tube amplifiers powering elaborate music systems that were almost as flashy as the automobiles of the period. Even computers all continued to be designed and built with tubes. Meanwhile, Shockley, Bardeen, and Brattain won the Nobel Prize for their transistor in 1956.

By the 1960s transistor devices were beginning to proliferate. Although most people liked the portability of transistor radios and record players, many were dissatisfied with the new technology, particularly audiophiles, who insisted that transistor hi-fi amplifiers sounded awful compared with tube models. "Originally the audiophiles were right," says David Rich, an electronics and acoustics engineering professor at Lafayette College. "When the first transistor amplifiers came along, there were a number of design deficiencies." These included poor reliability, harsh and distorted sound, and in some cases an unfortunate tendency to burn out if pushed too hard. Audiophiles also resented the hi-fi industry's relentless hard sell. "It was sort of like if you weren't behind this progress, there was something wrong with you," recalls John Atwood, an engineering consultant. The poor quality of many early transistor products made people feel they were taken in by the manufacturers.

But the transition to solid state was inexorable. "The engineers identified the problems and fixed them," says Rich. "By the late sixties they were basically solved. We ran out of things to find wrong with the amplifiers." As transistors and solid state designs steadily improved, manufacturers stopped using tubes in new equipment. "Tubes just kind of faded out," says Charlie Kittleson, an engineer, a hi-fi historian, and the publisher of *Vacuum Tube Valley* magazine. "Pretty much in the seventies and earl) eighties they died out." By the time the digital revolution brought microprocessors into everything from stereo systems and TV tuners to refrigerators and oven timers, tubes were considered a dead technology and were no longer taught to the new generation of designers. "When I went to [electrical] engineering school, vacuum-tube stuff was in the appendix, and the class never got there," remembers Barry Mann, the owner of David Mann Audio, a high-end hi-fi retailer in Philadelphia.

So as the twentieth century drew to a close, vacuum tubes were first banished to the back of the engineering textbooks and then taken out of the books altogether, consigned to the trash heap of technological history. For most applications the demands of modern technology have far outpaced the tube. If your personal computer were built with tubes instead of integrated circuits, it would be bigger than your house.

Despite its obsolescence in modern engineering, however, for some people the vacuum tube performs magic far beyond anything made possible by digital microelectronics. For one group it never went away. For another, it's a focus of intense controversy and almost cult like devotion. And aside from these enthusiasts, tubes still find employment in some unusual but vital applications.

BY FAR THE BIGGEST MARKET FOR TUBES, one that has remained robust throughout the rise of solid-state and digital electronics, is for guitar amplifiers. Legions of electric guitar players refuse to use anything but tube based amplifiers, because tubes impart certain sound and distortion effects that transistors can't easily mimic. The screaming wail of a Jimi Hendrix lead, the soulful warmth of an Eric Clapton solo, and the thunder of a Pete Townshend power chord all result from the intimate interplay of the guitarist, his instrument, and the unique distortion provided by a vacuum-tube amplifier. What began in the 1930s and 1940s as a means of amplifying a solid-body guitar or powering the guitar so it could be heard over the brass of a big band became an extension of the instrument itself as the rock era opened. "The sound of the amp and speaker became the major part of the desired 'tone,'" says John Atwood.

Amplifier makers such as Fender, Marshall, and Gibson realized that their goal wasn't to faithfully reproduce sound, as in a hi-fi system; after all, the solid-body electric guitar can barely be heard without amplification. Instead, the job of the amplifier was to allow a musician to create a sound. Control of the sound's volume was only a small part of it. As the music historian Tom Wheeler puts it in *The Guitar Book*, "A classic guitar, in skilled hands, can make an audience weep. But it can't vibrate their seats. The electric guitar's split personality can accomplish both." Dale Curtis, Fender's vice president of research and development, explains: "If you play quietly, there's less distortion; as you play louder, there's more distortion. This lets the guitar player be expressive without adjusting the knobs. Tubes give an infinite palette of sound simply by playing harder or softer."

As transistors replaced tubes in other electronic equipment, guitar-amp manufacturers began to follow suit, but rock musicians stubbornly refused to get with the program. Solid-state amps might be lighter, require less maintenance, and take more abuse, but they just didn't sound the same. Players complained that the transistors sounded "too clean" or "too bright" at normal volumes and "harsh" and "irritating" at higher volumes. Tube amps were "warmer" and "gutsier" and sounded better at high distortion levels.

AMP DESIGNERS, MANY OF WHOM PLAYED GUITAR themselves, understood that this was more than just rebellious rockers making trouble. The musicians had a point. There's no such thing as a perfect amplifier; every electronic circuit, whether it uses vacuum tubes, transistors, or black magic, imparts some degree of distortion to any signal put through it. For most purposes, this distortion is trivial, but when an electronic signal is being sent to a speaker to be converted into sound waves, it's critical, because it directly affects what we hear. A musical tone is a complex sound consisting of a fundamental frequency (an A at 440 hertz, for example) and many overtones or harmonics that are multiples of that frequency. For reasons that are still not fully understood, even numbered harmonics tend to sound more pleasing to the ear than odd numbered ones. The second harmonic of A is 880 Hz, exactly twice the frequency and an octave higher, thus blending pleasingly with the fundamental. The addition of an overtone an octave up is the sort of harmonic distortion that vacuum-tube circuits produce, while transistors tend to produce odd-numbered harmonics, because of basic differences in the way they amplify a signal. Many people sense those odd-numbered harmonics, perhaps largely subconsciously, as dissonant and irritating. As Douglas Fearn sums up neatly in *Pro Audio Review*, "Tubes sound better because their distortion products are more musical." (The same distinction exists for hi-fi amps and is a basis for the tubes-versus-transistors argument in that realm, but there especial effort goes into ensuring the sheer accuracy of the amplified signal, since hi-fi amps aim to reproduce a sound, not create one.)

So vacuum-tube guitar amplifiers never went the way of tube TVs or radios. In part it's a matter of sheer practicality. "You can get these sound effects with very simple circuits with tubes that are very difficult to do with transistors," says David Rich. Transistors can make even-numbered overtones, but it's much harder: "It takes many, many transistors to do what one tube can do." A historical imperative is also involved. In 1998 Eric Barbour, then an engineer with the tube maker Svetlana Electron Devices, explained in the engineering journal *IEEE Spectrum* that "the use of tubed amplifiers in the early rock of the 1950s and '60s caused their distinctive distortions to become the standard tonal effect for the electric guitarist." Rich concurs: "Music exists in a time period, and the technology for that time period is read into it. If you want to perform Bach, you'd better wheel out a harpsichord. A guitar amplifier is a similar thing. A certain capability was created around this technology, and you need to preserve it for the artist."

When the aim isn't the creation of music but its reproduction, however, matters are much more contentious. The distortion qualities so prized by musicians, who create new sounds, are a defect for audiophiles, who seek to reproduce an ideal of aural perfection. While average music listeners, and even most audiophiles, are generally content with today's extremely sophisticated digital solid state stereo systems, and engineers contend that modern designs have eliminated the troublesome aspects of older solid state models, a small but passionate group of tube enthusiasts begs to differ. A tubes-versus-transistors debate has raged within audio circles ever since the first transistor stereo amplifier came on the market 40 years ago. It can be nearly religious in its intensity.

IT IS NOT AN INTELLECTUALLY RESPECTABLE DEBATE nowadays any more than is typewriting versus word processing," writes Peter Aczel, editor and publisher of *The Audio Critic*. "Anything that vacuum tubes can do, solid-state devices can do better, more reliably, and at lower cost. Even the deficiencies of vacuum tubes, such as relatively high second-harmonic distortion, can be mimicked by solid-state circuitry if the designer happens to like the euphonious coloration that results." David Rich agrees: "When double-blind listening experiments are performed, any perceived differences between well-designed tube equipment- equipment that measures well in test—and modern transistor amplifiers can be shown to be unverifiable, if an experiment is run with enough trials to be statistically valid." From a scientific standpoint, if the amplifiers' specifications match, no audible differences should exist.

Still, as Charlie Kittleson explains, "To many music lovers, tube amps add more realism, excitement, and dimension to prerecorded sound. Solid state amps can sound two-dimensional and are typically harsh and less musical." According to tube loyalists, Kittleson says, "tubes color the sound warm; solid-state colors it cold and brittle. People buy these huge 500-watt solid-state amps, and they wind up pacing around their apartments or their New York townhouses, feeling something is missing in the music. Then they go over to somebody's house and listen to a little tube amp, and they're sold. And it's not just because tubes glow in the dark or look cool, although that's part of it too."

In other words, their response is a curious mix of the objective and the subjective. Almost nobody would seriously argue that tube systems and transistor audio systems are exactly the same; there are obvious physical differences in what they do and how they do it. The question is just how much those differences matter and to what degree they affect the sound produced. Terms such as *warm* and *cold* or *brittle* and *flat* are hardly scientific and are impossible to define precisely, yet they have definite meaning to many people, although that meaning can vary widely from individual to individual.

One problem is that aural perception is a highly subjective and personal phenomenon with a wide range of variation. Consider fingernails scraping across a blackboard, for example; one person simply shrugs the noise off, while another endures it as torture. Exactly the same sound reaches both sets of ears, but it produces two very different psychological and physiological responses. Even a single individual reacts to the same sound differently at different times, depending on such various factors as his or her emotional state.

Another difficulty is that it's impossible to compare two sound sources separately yet at the same time. David Rich elaborates: "If you have two pictures right next to each other, you can physically look at both pictures and see differences. You can't do that with sound. There's a perception problem in that every time you hear something, you hear something different. You hear different things simply by having the event occur again and knowing in advance a little more about what the event is. And aural memory is pretty lousy for short-term events. Humans are not capable of accurate short-term memory of an acoustic event, so it is easy to believe one has perceived a difference that doesn't exist."

Unfortunately, the lack of definitive answers—or, perhaps, the reluctance of some to accept particular answers—makes the high-end audio field a fertile ground for rumors, misperceptions, and obsessive behavior. "There are doctors and attorneys and kooks with extra money who are willing to spend $50,000 or $60,000 on a two channel stereo system and then $10,000 or $20,000 a year upgrading cables and other accessories," Kittleson points out. "It's just like the guy who has to have a Ferrari to feel good, while the next guy is satisfied to drive around in a Volkswagen." Deception and various forms of chicanery are also rampant. "At the Consumer Electronics Show in Chicago every January, there are rooms upon rooms upon rooms of manufacturers selling amplifiers," says Rich. "And each one is trying to convince these very few rich people that his amp is the one, because it has silver lining in the transformer or a new tube discovered in Yugoslavia. It's a little pseudoscience and very much presentation."

ARE THE "AUDIO geeks" right about vacuum tubes? It depends. Objectively, probably not; subjectively, of course. Barry Mann, who deals with such questions every day, observes, "I find that each time technology changes, there's a group that wants to stay back." He compares the transition to solid state with the shift from 78s to LPs or from LPs to CDs, and he takes a diplomatic view of the debate: "There is a different sound, and it's fine if you want to like one or the other." It's up to the listener to decide which he or she likes better, since perfect sound is impossible to define anyway. "None of this equipment is perfect," he says, indicating the state-of-the-art audio gear surrounding him. "I think there are distortions we aren't even modeling that are significant to our aural processing system and aren't represented by any numbers that we know yet. We don't know enough about how we hear to come up with a good description of an aural experience. If I give you the job of describing a cricket so that I might recognize one if I see it, that's doable. But to describe the cricket's sound so I might recognize it if I hear it, that's tough."

The vacuum tube business today is probably one of the world's great unknown industries. Some American makers remain, but many of the top manufacturers now are in the former Soviet bloc, in such countries as Russia, the Czech Republic, the Slovak Republic, and Serbia, as well as elsewhere in Europe and in China. "The worldwide tube market is well over $100 million a year," Kittleson says. Tube makers generally re-create tried-and-true past designs, sometimes with modest modifications and improvements.

Aside from their continued use in music and audio, vacuum tubes are still the weapon of choice for certain other applications. One is very common: the microwave oven, which uses a special tube called a magnetron to generate the gigahertz-range frequencies needed to cook TV dinners. Tubes are also still useful in industrial and communications equipment. "Tubes do very well as high-frequency, high-power amplifiers," Atwood says. "It's an area where they still can be more cost-effective and more reliable than semiconductors." Although they may hardly seem space-age, traditional vacuum tubes hum away in many communications satellites, working in tandem with the latest microelectronics to handle high-powered microwave transmissions. Back on earth, large, high-wattage radio and television stations rely on huge, metal jacketed, water-cooled vacuum tubes to power their transmitters at levels transistors could never withstand. lean Shepherd was right.

The military has always been a chief user of vacuum tubes, even after transistors took over in other areas. One reason is that they can withstand severe overloads without being damaged. High power radars therefore use tube circuits, as do the electrical "pulse weapons" currently under development. The long-lived B-52 bomber and other military aircraft, American and otherwise, still employ tubes in some of their avionics, partly because of one quality that was especially appreciated during the Cold War, their virtual invulnerability to ionizing radiation and to the electromagnetic pulse that accompanies a nuclear detonation. "This might be an important consideration to those audiophiles who plan to use their equipment after the nuclear holocaust," an article in *Vacuum Tube Valley* magazine has dryly remarked.

Sometimes the military has even gone back to tubes after abandoning them. According to Kittleson, "In Desert Storm, the solid-state receivers picked up unwanted radio frequency interference and noise from transmitters and other equipment. They had to go back to 1950s vacuum-tube receivers in certain applications because they were less susceptible to RF interference."

The most sophisticated use of the vacuum tube yet may come in a marriage of Lee de Forest's old triode and the latest microelectronics. In 1999 Alexander Driskill-Smith, David Hasko, and Haroon Ahmed, at Cambridge University, developed a prototype nanotriode —a microscopic vacuum tube less than 100 millionths of a millimeter across, composed of layers of metals and insulators surrounding a minute cavity. Tiny pillars acting as a cathode inside the cavity emit electrons by a field emission effect to an- other part of the cavity that serves as an anode. A separate layer of metal functions as the control grid. The nanotriode offers all the best qualities of a vacuum tube, including its ability to handle high frequencies and its resistance to heat and radiation. In the new century, the microscopic transistors in today's silicon circuits may yield their supremacy to the nanotriode much as the traditional tube yielded to the transistor, in which case technology will have come full circle in form, if not in appearance.

Driskill-Smith and his colleagues might agree with Charlie Kittleson when he says, "Vacuum tube technology is a classic electronic technology that's not going to go away. Why abandon a technology just because it's old?" The stubborn longevity of tubes demonstrates that sometimes we may be a little too quick to discard the old in favor of the new. Once in a while even the obsolescent can have a few surprises and tricks in store. Certainly, few would have expected that microscopic vacuum tubes were possible.

If the nanotriode eventually heralds the next generation in electronics, will it finally settle the endless tubes-versus-transistors debate among audiophiles? If history is any guide, definitely not.

MARK WOLVERTON wrote "The Airplane That Flew Into Space," *about the X-15, in the Summer 2001 issue.*

Swap Column:

Any swaps or items for sale in the antique line ? Let me have the details and we will advertise it here.

I have a Geloso TR212 from a deceased estate. Wanted price is R500 onco. As far as I am aware, the rig was in working order. The case is in good condition, but the plastic dial cover has a crack in it. Please contact me if you are interested in this rig. I have a manual for the rig too.

If you would like to forward this newsletter to any other interested parties, please feel free to do so. Print it out and put in on your club notice board, or give it to someone interested in valve radios. If you know of any who report in on the net but don't have email, print it out and give them a copy.

Net days and times:

Saturday 06:00 AM Net – frequency 3615Mhz

Saturday 08:30 SSB net - frequency – 7070 with a relay on 3615

Saturday 14:00 CW net – frequency 7020Mhz

Wednesday 19:30 AM net – frequency 3615 (-5 for QRM)

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