Vintage Radio

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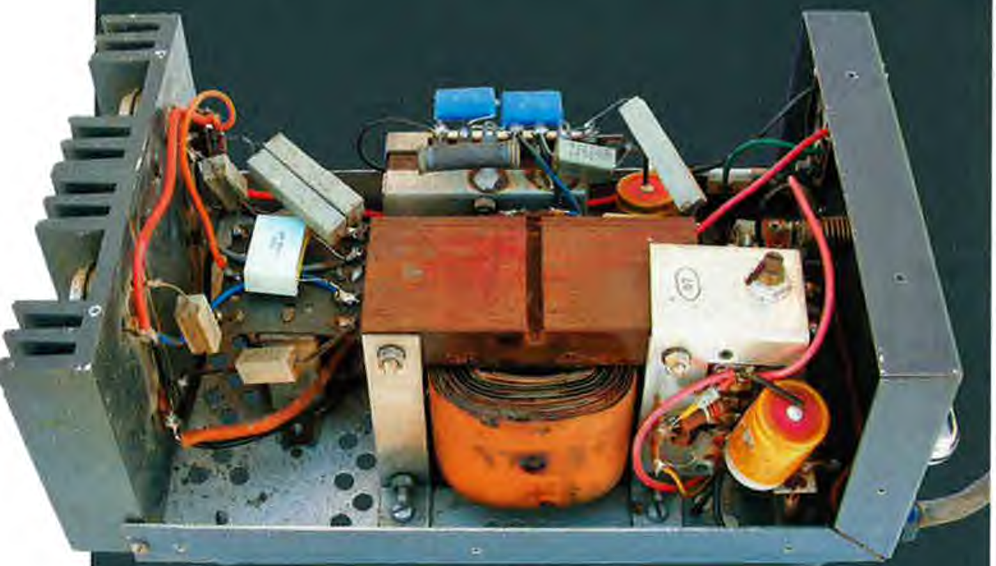
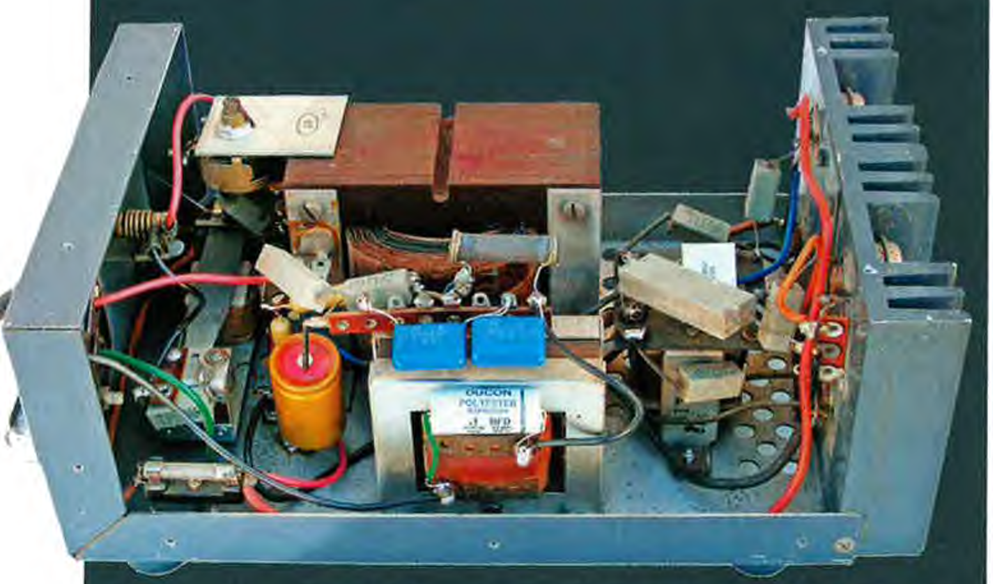
More DC-to-AC Inverters From The Valve Era





These two views show the internal construction of the AWA VB-32 inverter (photos taken after restoration). The germanium power transistors were mounted on the finned heatsink.

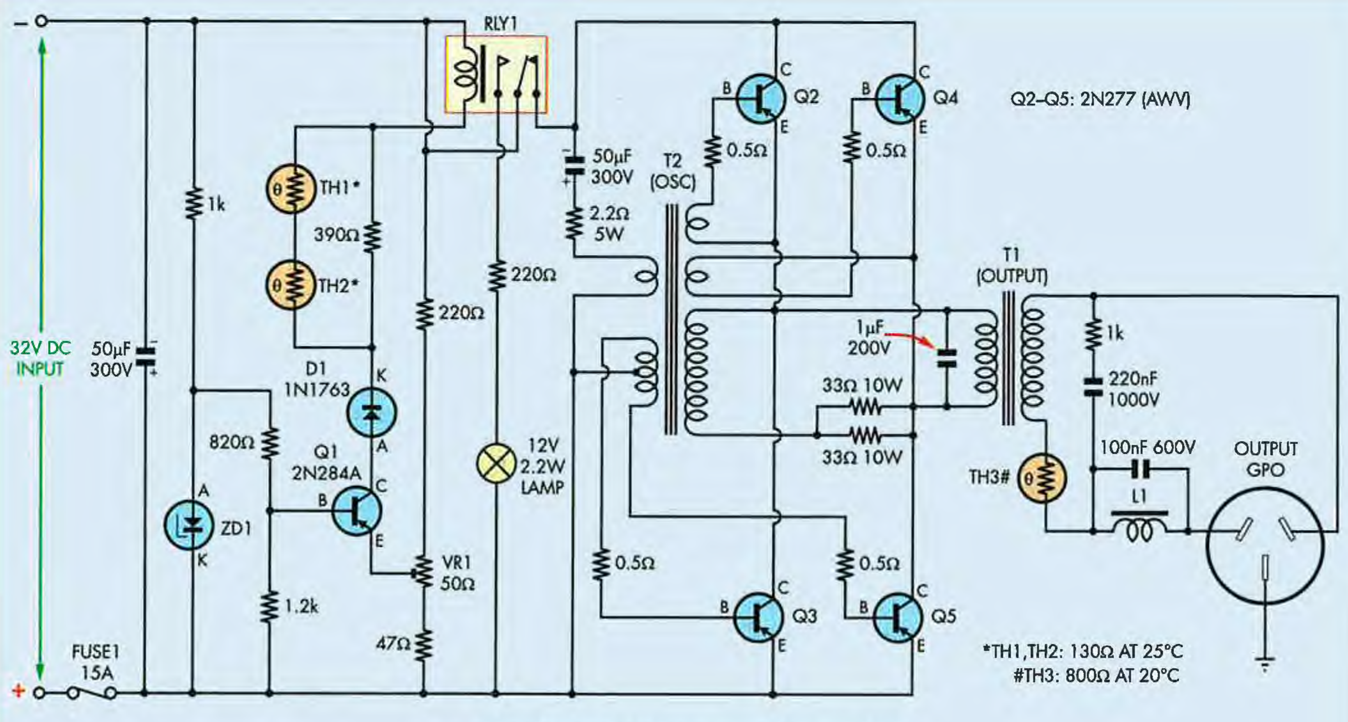
DC-to-AC inverters were essential in many rural areas for powering mains equipment from 32V DC lighting plants. Here we take a look at the AWA VB-32 transistorised inverter and the Ferris vibrator inverter, the latter often used to power car radios.

MANY RADIOS DESIGNED for rural areas ran off batteries during the valve era, since a mains supply was often not available. Often, this involved using separate batteries to power the filament, bias and high-tension (HT) circuits.

By contrast, those sets designed to work from a 6V wet battery used a vibrator power supply to derive a 90V or 135V HT rail for the plate supply. The filament wiring of the valves was arranged so that they could run from the 6V battery.

Other valve radios were designed to work off 12V, 32V, 50V, 110V and 240V DC supplies (eg, from home lighting supplies and small town power plants). In fact, 32V DC home lighting plants were common in farming communities and other areas remote from the reticulated 240V AC mains.

Unfortunately, not many appliances were designed to work off 32V. As a result, several manufacturers built 32V DC to 240V AC inverters to power mains devices, such as radiograms and later on, TV receivers. To my knowledge, only Ferris radio produced a 32V DC-operated TV receiver, this



AWA VB-32 TRANSISTOR INVERTER UNIT

Fig.1: the AWA VB-32 used four germanium transistors to provide push-pull drive to an output transformer. Q1, ZD1 and their associated parts form a protection circuit which switches off the inverter if the input voltage exceeds 36V.

being back in the valve black and white era.

Vibrator inverters

In the June 2007 issue, we described two vibrator type DC-to-AC inverters. The larger of these – a Van Ruyten 200W unit – was designed to power a TV receiver from a 32V supply. Ferris Radio also produced a small 30W vibrator unit that could power AC/battery portables (or other small low drain devices) from 6, 12 or 32V DC

AWA VB-32 inverter

The development of high-power germanium transistors during the early 1960s saw the demise of vibrator inverters. Transistorised 200W inverters were quickly released by a number of manufacturers, the AWA VB-32 being just one example.

The VB-32 probably came onto the market in the early 1960s and used four germanium power output transistors in a flipflop-type oscillator circuit. It produced nominally 60-65Hz 240V AC at up to 180W from a supply of 32V DC.

The model I have is the VB-32 whereas the information I have is for a VB-32QA, which is a later version. The only difference between them seems to be some minor changes to component values plus the use of a different transistor type for Q1.

Fig.1 shows the circuit details of the unit. We'll describe how it works shortly.

Boning up on VB-32

Before commencing restoration of the VB-32, I sat down and carefully read the Technical Information and Service Data booklet for this device. From the content, it was obvious that AWA thought that the servicemen of that era needed some tuition on how transistors worked.

This was probably a wise move, as transistors were relatively new at that time and servicemen were often not very conversant with transistor theory and practice. This particularly applied to country servicemen, as they did not have much access to training seminars and courses. Instead, most (if not all) of their training was through books and correspondence courses – and there was probably a lot of trial and error learning as well.

At that time, transistors were almost exclusively germanium PNP types. With valves, the chassis was generally more negative than the plate circuits, which had positive HT applied to them. By contrast, transistors were current-operated devices. Those early circuits usually had the positive rail connected to chassis, operated from quite low voltages, did not like short circuits or heat and, of course, had to be biased "on" to operate.

It was quite an education to read the literature on the device. It gives a blow-by-blow description of how transistors work, describes the circuit functions, sets out the adjustment procedure for the over and under-voltage settings, and describes how to do measurements around the circuit. It even describes how the transistors are mounted to prevent them from being damaged.

Protection circuitry

It's also worth noting that the design includes features to ensure that the transistors are not damaged by reverse polarity or over-voltage. In addition, there's no on-off switch on the device, to minimise voltage losses in the supply circuit.

Continuing the latter point, the manual includes notes specifying the size of cable necessary between the 32V

This is the AWA VB-32 inverter following restoration. It produced nominally 60-65Hz 240V AC at up to 180W from a supply of 32V DC.

battery bank and the inverter. If the 32V is connected back-to-front, no damage occurs as the MR2 protection diode does not conduct. As a result, no voltage is applied to Q1 and relay RLY1 can not operate to supply power to the inverter circuitry.

The main purpose of the control circuit at the left of Fig.1 is to turn the inverter off if the input voltage exceeds 36V. In operation, zener diode MR1 sets the reference voltage, while trimpot VR1 sets the trip voltage. When the input voltage exceeds 36V, the relay switches off and removes power from the inverter circuit.

In addition, the relay turns off if the voltage goes below about 26V. This protects the 32V battery bank from damage due to deep discharge. When the relay is off, its NC contacts apply power to an indicator light on the front of the unit to indicate high or low supply voltage.

Bad practice

In the manual, AWA suggests that the inverter could be tapped down the battery bank if the supply voltage was too high. However, this would mean that most of the battery bank would be discharged by the inverter but a cell or two would remain at full charge, as they were not part of the circuit. As a result, these cells would be regularly overcharged which is bad practice.

Of course, this would be only likely to occur if the 32V lighting system was in fact set up as a 34V or 36V system. This was sometimes done to overcome voltage losses over long supply cables.

These paper capacitors from the AWA VB-32 inverter all failed high-voltage leakage tests and were replaced with modern polyester types.

This was also the reason for the over-voltage cut-out circuit in the inverter. Together with the reverse voltage cut-out circuit, this served to protect the transistors from catastrophic failure. High-power transistors were not cheap in the 1950s and 1960s.

There are a couple of additional features that are worth noting. First, inductor L1 and its parallel 100nF capacitor are broadly resonant at the output frequency. This helps modify the output waveform so that it is not so much a square-wave but a waveform that more nearly approaches a sinewave.

Second, thermistor TH3 in the output line provides a "soft" start feature, so that the supply voltage builds up to maximum over a short period of time. This is not only kinder to the TV receiver it is powering but also kinder to the inverter itself.

Restoring the VB-32

I had hoped to restore my VB-32 inverter some time ago but had been unable to find the technical notes or a circuit until recently. When these items were finally obtained, I set to work and removed the top cover which also exposes the sides of the unit.

Two iron-cored transformers and a choke are the most noticeable components, along with several wirewound resistors and capacitors (including some paper types). No horrible smells greeted me and nothing looked the worse for wear. The plastic insulation around the two electrolytic capacitors had shrunk but they subsequently proved to be in good working order.

Based on previous experience, I was particularly interested in the condition of all the paper capacitors. This was heightened by that fact that when restoring a Van Ruyten inverter some time ago, I found several paper capacitors with their insides on the outside.

Anyway, I tested them all on my high-voltage leakage meter and none of them passed the test. It's interesting to note that one of these capacitors was rated at 1600V and another at 1000V. I would have thought that these two at least wouldn't have had much leakage but they did.

In the end, the low-voltage units were replaced with polyester types with the same ratings. However, I couldn't do this with the two high-voltage types, so I used two capacitors

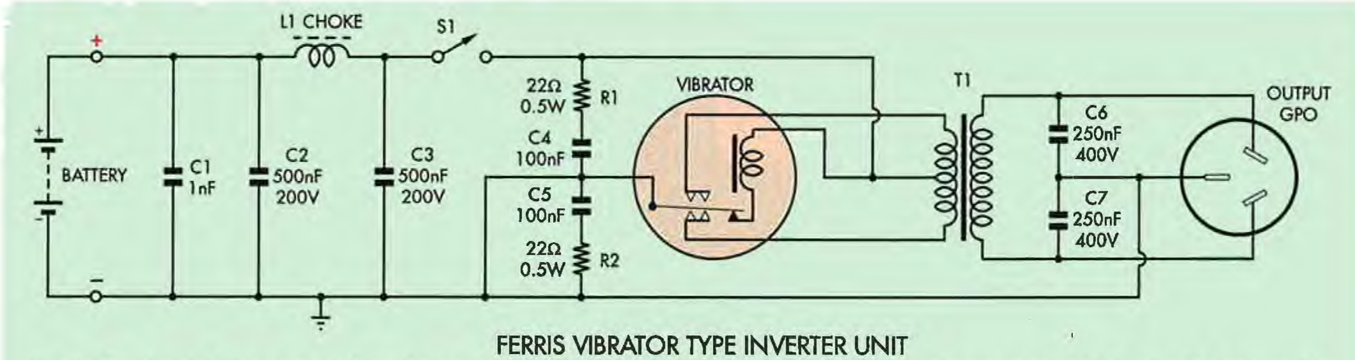


Fig.2: the Ferris inverter used a vibrator to drive the output transformer. This basic circuit could be made to operate from 6V, 12V or 32V DC simply by changing the transformer, the vibrator itself and one or two small components.

in series in each case (both double the original value) to obtain the required voltage rating.

By the way, a 10nF 1600V capacitor isn't shown on the circuit diagram. It's wired between the active 240V output terminal and the chassis of the inverter.

Next, I checked the over-voltage relay RLY1 and found that one set of contacts had badly tarnished. In fact, they were so bad that my multimeter indicated an open circuit between them when they were closed. They were cleaned by holding the contacts closed while rubbing fine wet and dry paper between them.

Having fixed the relay, I then dusted out the cabinet with a small paintbrush, after which I cleaned all the surfaces using household kerosene on a rag. This works well and leaves the metalwork with a slightly bright appearance, although there are a few obvious "wear and tear" marks in various places.

Having done all that, it was time for the smoke test (well hopefully, there wouldn't be any smoke). There is a fuse in the positive line in the inverter and as my 32V power supply is only capable of supplying around 3A, I wasn't expecting any problems.

I connected the supply, switched on and the inverter immediately produced a low-frequency buzz, indicating that it was working. What's more, it immediately lit a 25W globe that was plugged into the outlet socket.

In short then, this inverter is solidly made, with the circuitry well protected against over and under-voltage as well as reversed polarity. However, the control circuitry could have been made easier to get at, as there is plenty of room in the case.

In addition, the technical notes that were supplied by AWA are a real bonus. They are quite extensive and would have been very helpful to any serviceman who was unfamiliar with transistor equipment at that time.

On the downside, the wiring could have been tidier but it must be remembered that this unit was built at the start of the transistor era. The VB-32 may not be for every collector but for those who specialise in 32V equipment, it's well worth having.

The Ferris inverter unit

The next inverter that I want to describe was made by Ferris Radio. Ferris, for some reason best known to themselves, did not give this unit a model number, however.

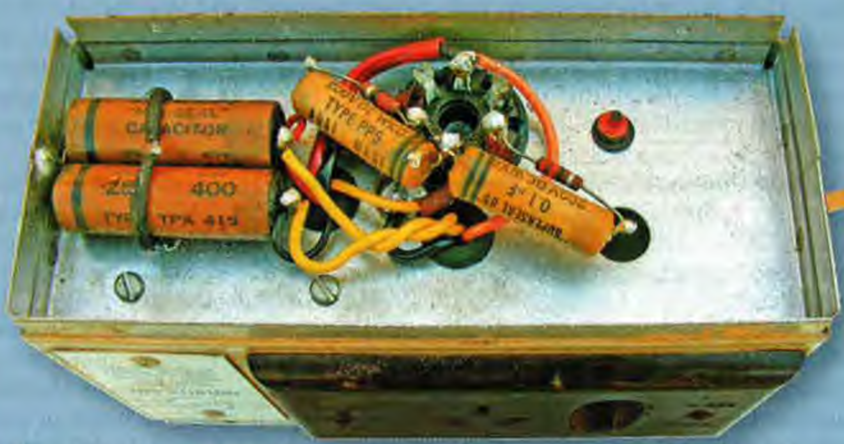
It's worth noting that Ferris came up with a number of niche market devices over the years and this inverter from around 1954 is one of them. The circuit was basically designed to operate off 6V, 12V or 32V DC simply by changing the transformer, the vibrator itself and one or two small components.

The unit's purpose was to power small 240V AC devices with a maximum power rating of 30W. However, unlike the Bland Radio inverter described in the June 2007 issue, the Ferris unit was designed to minimise radio (RF) interference, being fitted with a reasonable amount of filtering. As a result, it could be used on low-drain AC radios such as AC/battery valve portables.

In fixed installations, the Ferris

Fig.2: this photo shows the Ferris inverter after restoration. It was designed to power small appliances rated up to about 30W.

This is the view inside the Ferris inverter, from the top. The vibrator unit is located at bottom centre, immediately to the right of the transformer.



The original paper capacitors in the Ferris inverter were all leaky and were replaced. The two resistors were also changed.

This view shows underside of the Ferris inverter after restoration. The paper capacitors were replaced with polyester units.

inverter could be mounted in a farmhouse and supplied with 32V from the lighting plant. Alternatively, for powering a car radio, a 12V version could be mounted on the firewall of the vehicle.

The circuit of the Ferris inverter is relatively simple – see Fig.2. Power is applied to the unit via a shielded cable, which has a metal-cased fuseholder in series. This shielded cable is designed to assist with filtering any interference on the power input line.

Inside the case, the supply is further filtered using three capacitors and an RF choke arranged in a "pi" network.

Following the filter, the supply input then goes to the switch on the AC output socket. From there, the supply goes to the vibrator transformer and the vibrator.

The resistors and capacitors across the primary and secondary of the transformer act as both buffer capacitors and interference suppressors. The AC output of the unit has a frequency of about 100Hz, this being the vibrator frequency.

Cleaning up the case

The case of my unit had been mounted on a car firewall and carried quite a few marks. Most of these marks came off when it was given a rub-down using a cloth moistened with household kerosene. That done, a kitchen scouring-pad was used to remove some of the more stubborn marks while taking care not to damage the paint.

I did consider repainting the case but in the end decided that it wasn't sufficiently marked to warrant the trouble. The 240V power point was given a rub over with car cut and polish and it came up looking almost like new.

Overhauling the electronics

The case of the Ferris unit is opened by removing four screws in both the top and bottom covers. This showed that the internal assembly was still in quite reasonable condition.

Once again, after my experience with the Van Ruyten inverter, I looked closely at the buffer capacitors. I tested C4, C5, C6 & C7 and found that they were all leaky so they were replaced with new polyester capacitors.

Resistors give very little trouble usually but when I tested the 22Ω two resistors (R1 & R2) in this unit, I found that one measured 30Ω and the other varied between 30Ω and 500kΩ. As a result, they were both replaced.

Because the resistors were faulty, it was also quite possible that the vibrator itself had been damaged. To check this, I dismantled the vibrator and this revealed that there had been severe sparking at the points.

Initially, I attempted to clean the contacts by sliding a small piece of fine wet and dry paper between them, while applying light pressure with my fingers to keep the points together, Unfortunately though, after cleaning them, I was unable to get continuity across the points.

I suspect that the points themselves

were OK but were not making electrical contact where they were attached to the vibrating assembly. In the end, I gave up trying to get the original vibrator to work and substituted a new one from my parts collection.

Next, I checked the fuse and although this was intact, its rating (15A) was too high. In fact, the unit should draw no more than about 4A. I replaced the fuse with a 5A unit so that the device would be protected if a severe short were to occur.

Testing the Ferris unit

Before applying power, I checked for shorts between the input and the case. These checks proved to be OK so I connected the supply and switched on. The result? – nothing happened!

Initially, I thought that there might be a problem which had blown the fuse but this was found to be OK. I then checked further and found that the inner power lead was continuous but there was a break somewhere in the outer braid.

I cut the terminals off the end of the cable and slid the fabric cover off. The braid was extremely corroded and in one spot it was just a bunch of oxidised strands with no conductivity across them. As a result, I completely replaced the cable – it was just too badly corroded to salvage.

I used some shielded hook-up wire to replace the original cable but slipped the fabric cover back over this new cable so that it looked like the original.

Once this was done, I reconnected power to the inverter and it quite happily supplied power to a 25W 240V globe. I then tried a portable radio near the inverter and found that the weak stations were drowned out by the interference. However, the stronger stations suffered very little interference.

In practice, the interference along the 12V line was low but was quite pronounced near the 240V AC output. Perhaps if Ferris had paid as much attention to filtering of the output as they did to the input, this unit would have been able to power portable radios with virtually no interference.

In summary, the little Ferris inverter is quite a good performer and is a much better unit that the Bland Radio unit described in June 2007. It has a better vibrator buffer system and better RF filtering. **SC**

Photo Gallery: 1949 Astor Model GJ

THE FIRST AUSTRALIAN RADIO IN A BAKELITE case was the AWA C87, launched in 1932. It was a 3-valve set and the valve line-up was as follows: 35 RF amplifier, regenerative 24 detector and 47 audio amplifier. This set is now one of the most sought-after by vintage radio collectors. Photo: Kevin Poulter, for the Historical Radio Society of Australia.