BATTERY ELIMINATORS

Batteries were the only practical power source for early receivers, and with the advent of domestic radio, they were criticised for their expense and inconvenience. It is interesting to look at the efforts that were made to use AC mains power as an alternative source.

Three quite different types of battery were required to power the early valve receivers. The 'A' supplies needed to heat the valve filaments were generally 6 volts or less, but with current demands often in excess of an ampere, so secondary batteries or 'accumulators' were often necessary.

In contrast, the high tension (HT) or 'B' supply needed for the valve plates typically only needed to provide only 20mA of current, but at considerably higher voltage: from 45 to above 100 volts. Although small capacity lead-acid batteries were sometimes used, high tension supplies were generally made up of batteries of dry cells.

Very early receivers didn't use 'C' batteries to provide grid bias, and in later years, bias voltages were often obtained automatically from the 'B' supply. But when separate bias supplies were used, the virtually zero current requirements meant that 'C' batteries could use small dry cells – which lasted as long as their shelf lives. They were relatively inexpensive, and the biggest problem was that their voltages remained constant while those of their companion 'B' batteries fell with use.

One solution was to dispense with the 'C' battery and derive bias from the voltage developed across a resistor in the HT return (negative) lead.

Accumulators unpopular

In professional communications and marine installations, the cost of batteries was of little consequence, and there were trained operators to look after charging and maintenance requirements of accumulators.

However, with domestic radios, the situation was different. The popular American 201A valves had filaments rated at 5 volts at 0.25 amperes each, although somewhat lower consumption European types became available with 4.0V, 6.0V and later 2.0V filaments. Filament batteries, with capacities of up to 100 ampere-hours had to be carted off every fortnight or so to the nearest garage, radio or bicycle shop for charging, leaving the radio out of action. To provide a second battery to cover this period was an additional and considerable cost, leading one enterprising British firm to run a 'swap a battery' charging and delivery service.

To cater for radios in areas without charging facilities, the American '99, '–11 and '–12 valves were developed. These could be operated from a battery of heavy duty dry cells, as could the Philips 'A' series and their equivalents from Europe; but it was an expensive exercise. RCA's recommendation for a filament battery for their Radiola 28 receiver equipped with '99 type valves was a series-parallel group of 12 'No.6' dry cells – which would be priced today at upwards of $10 – each!

Little wonder then, that in the mid 1920's there was intensive research into the development of AC heated valves and mains powered HT supplies. And for existing receivers, a thriving market developed for mains powered 'battery eliminators'.

Battery eliminators

Low consumption directly-heated valves were very sensitive to any filament supply hum. Initially, as capacitors of only a few microfarads were available, considerable difficulties were experienced in producing adequately filtered mains powered 'A' supplies.

However as the HT requirements of battery receivers rarely exceeded 30mA, tolerable hum filtering was possible with modest filter chokes and paper capacitors, and 'B' and 'C' battery eliminators soon appeared – although compared with batteries in good condition, their performances left a bit to be desired.

Basically a B-C battery eliminator consisted of a transformer, rectifier, filtering system and voltage dropping resistors. The biggest problem was regulation of the intermediate voltages (needed for screen grids, etc), which were derived through resistors. Getting the right tappings often involved a bit of experimentation.

A notable 1925 development by RCA to cope with the regulation problem was the first gaseous voltage regulator, the 90 volt UX-874, an analog of the modern solid state zener diode.

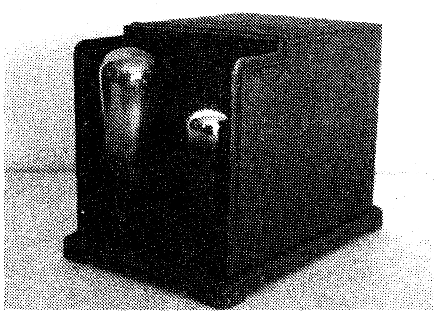


Fig.1: The Philips 3003 'B' and 'C' battery eliminator, shown here with the valve cover removed.

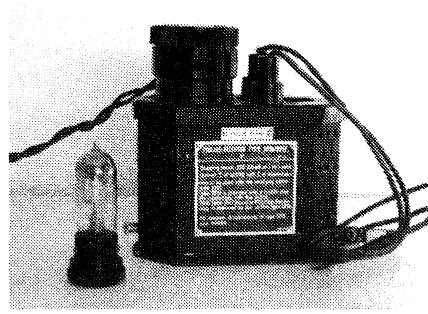


Fig.2: The companion Philips 1017 trickle charger for 'A' batteries, with its tiny mercury-vapour rectifier.

Several rectifiers

A variety of rectifier types was used, including the familiar high vacuum diode. Other types used included copper oxide, copper sulphide, cold and hot cathode gaseous, and electrolytic rectifiers – used in bridge, biphase and half wave configurations.

High vacuum double diodes for 'B' eliminators became available during 1925. The Westinghouse type UV-196 was unusual in having a single anode and two filaments! As described in our August 1988 column, its more conventional companion the RCA UV-213 was later upgraded to become the best known rectifier valve of all time – the 80.

Raytheon's series of cold cathode helium-filled rectifiers was popular. Although having the advantage of requiring no heating current, gaseous rectifiers needed a minimum 'striking' voltage for reliable starting.

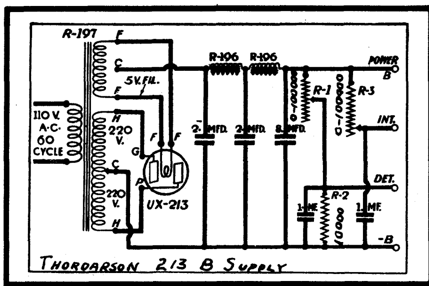
Copper oxide and copper sulphide rectifier stacks were early examples of semiconductor diodes. As each segment was limited to about 10 volts, these rectifiers were most frequently used for low voltage applications and were used for battery chargers until recent times.

Hot cathode mercury vapour and argon filled rectifiers were also popular for battery chargers.

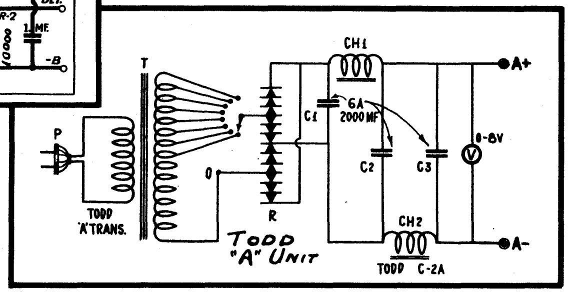
Electrolytic rectifiers

A somewhat bizarre rectifier, known irreverently as the 'slop jar', the electrolytic rectifier or Noden valve consisted of a glass container containing an electrolyte and a pair of electrodes. The cathode was pure aluminium or tantalum, but the anode could be iron, carbon or lead. Borax, sodium bicarbonate, sodium phosphate, ammonium borate and ammonium phosphate were some of the chemicals used for the electrolyte. Each cell could handle up to 50 volts and electrodes were rated at about 40mA per square inch. A typical rectifier for a 'B' eliminator was a compact group of eight quite small jars.

Electrolytic rectifiers could be home



Left: An example of the classic biphase or full-wave rectifier 'B' supply, using a UX-213 dual-diode valve rectifier. Note also the twin filter inductors or 'chokes'.



The circuit for the American 'Balkite' AB 6-135 eliminator, which used half-wave electrolytic rectifiers for both 'A' and 'B' supplies.

made, and for some years the ARRL Amateur Handbooks gave full instructions for their manufacture. An HT supply for a transmitter needed an array of jars that could be rather messy, untidy and potentially lethal!

Mercifully, electrolytic rectifiers eventually disappeared, but they left us with an invaluable legacy – none other than the electrolytic capacitor. Today, electronics technology as we know it would not be possible without the electrolytic capacitor in its various forms.

Replacing A batteries

The advent of the electrolytic capacitor meant that sufficient capacitance for filtering filament supplies became available, but initially it was necessary to continue the use of filament batteries. Some compromise was provided by home battery charging.

It was possible in areas with DC power mains to connect a secondary battery in series with some of the household lamps, and have the charging done more or less free. A safer method when AC mains were available was to use a trickle charger, such as the Philips 1017 Rectifier Unit illustrated in Fig.2.

Often, hum and noise were sufficient to prevent the charger being used while the radio was in operation. The radio, battery eliminator, charger and filament battery could be interconnected so that when the radio was not in use, the battery was charging. Turning the radio on by means of the circular knob on the top of the Philips 1017 charger switched the mains over to the B-C battery eliminator and connected the filaments to the A battery.

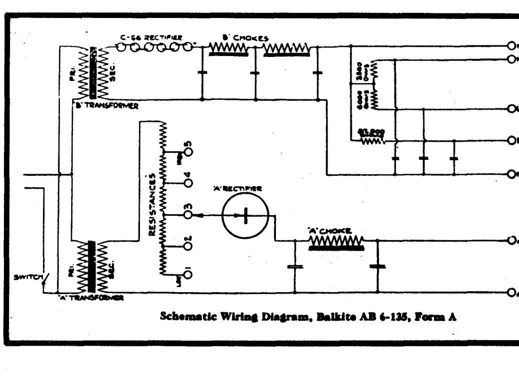
So when the radio was off, the 1017 trickle charged the A battery, but when the radio was on (with HT supplied by the eliminator), the 1017 went off, with the valve filaments running on the charge which had been stored in the A battery.

Some fully mains operated receivers were made which actually ran the valve filaments from the HT supply. Type '99 valves with their 60mA filaments connected in series were well within the capabilities of HT rectifiers and filtering systems, but some receivers actually lit 250mA UX-201A filaments from the HT supply, using a BA Raytheon gaseous rectifier rated at 350mA. One can only guess at the receiver hum level, with 4uF filter capacitors!

The system of heating series connected filaments from the HT supply was resurrected 25 years later, with portable Mains/Battery radios using the 1.4 volt/50mA valves.

About the time that successful 'A' eliminators became available, mains powered valves had appeared and the demand for eliminators declined, causing some manufacturers to switch to making receivers. This happened in America with the Majestic and Philco companies, and in Holland with Philips. All three went from eliminator manufacture to become giants in the radio industry.

The high cost and inconvenience of providing batteries for valve receivers is still a problem today, but modern technology has simplified the design of battery eliminators. Next month we will describe the construction of a 'universal' mains power supply for running battery operated valve receivers.



Right: 'A' eliminators only became practical with the development of electrolytic capacitors. This one used a copper-oxide bridge rectifier.