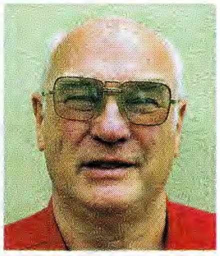


By RODNEY CHAMPNESS, VK3UG

Vibrators: the death knell of heavy, expensive dry batteries; Pt.2

Last month, we looked at the basics of vibrator power supplies as used in many vintage radio receivers. This month, we take a look at interference suppression in vibrator supplies and describe how to service them.

Fig.1 shows the circuit details for a typical vibrator power supply, in this case from a HMV 268/328 vibrator receiver. In operation, the vibrator (VIB) alternately "earths" the ends of the primary winding of T2, thereby causing pulses of current to flow through each half-winding to earth via vibrator contacts 1, 5 & 6.

The transformer (T2) steps up the primary voltage and the resulting secondary voltage is then rectified by contacts 2, 4 & 6 in the vibrator. The output, at the centre-tap of the secondary, is DC with ripple on it - much like the hum voltages in an AC supply. Note that the vibrator transformer has a "buffer" capacitor (C37) across it and this has voltage rating of 2000V.

A basic vibrator power supply generates considerable electrical interference (vibrator "hash") which left unsuppressed, will completely drown out all but the strongest radio stations. However, vibrator radios were mostly used in rural areas where radio signals were relatively weak.

Five typical vibrators (from left to right): Van Ruyten 32V 200W dual interrupter vibrator, Oak V6606 6V dual interrupter (with strapped pins) vibrator, Oak V5124 6V synchronous vibrator, Plessey 121HD4 12V non-synchronous vibrator and Ferrocart M437 6V non-synchronous vibrator.

To overcome the interference, radio frequency chokes (RFCs) were fitted in series with both the low tension (LT) rail and high tension (HT) lead. In Fig.1, these RFCs include CK1 & CK3 in the LT rail and CK2 in the HT rail. In addition, radio frequency (RF) bypass capacitors were connected between LT & HT rails and earth - ie, C40, C41 & C42. In practice, these bypasses were fitted near the RF chokes and as a result, interference on these lines was virtually eliminated.

However, a vibrator supply will also radiate interference directly from the supply leads and from other components prior to the filters. To overcome this, the supply is shielded within a metal box - sometimes double-shielded, as can be seen by the dotted line enclosures around the vibrator supply in Fig.1. The earth points in vibrator power supplies also had to be chosen with care and some supplies used "one point" earthing, where all leads that carry interference are earthed at one point only.

Battery filament lines

The battery filament lines are also filtered to remove any ripple and this is accomplished in Fig.1 by power choke CK5 and electrolytic capacitor C43. However, you may be wondering why the negative power lead and the positive power leads are split into two wires each. This was done so that the ripple along the vibrator positive and negative supply lines was not impressed onto the filament lines.

In practice, the battery filters out most of the ripple as it acts as a very large capacitor. Note that the voltage

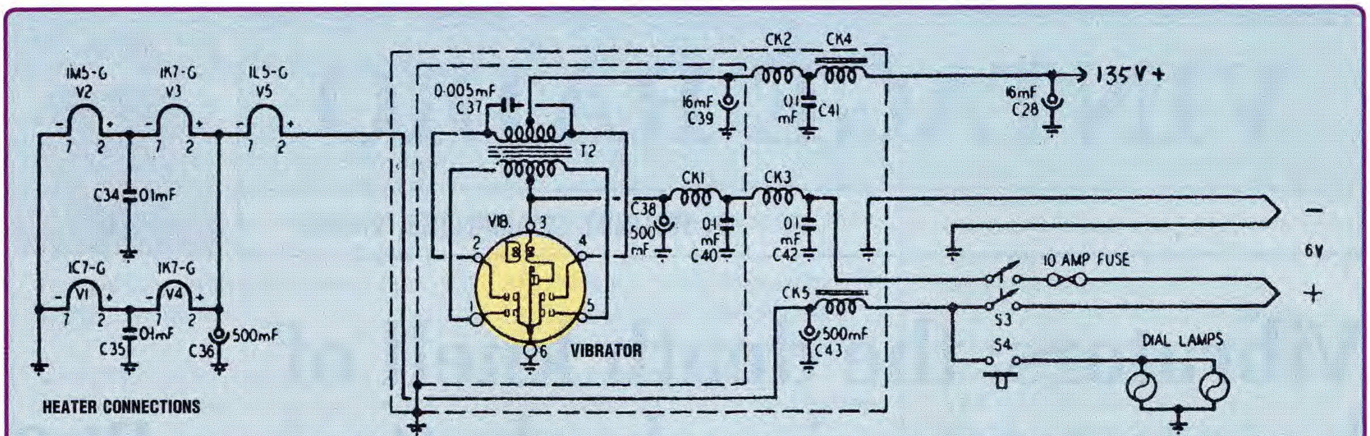


Fig.1: the circuit diagram for the HMV 268/328 filament and vibrator supply. The vibrator is a synchronous type, since it also rectifies the output on the transformer secondary windings.

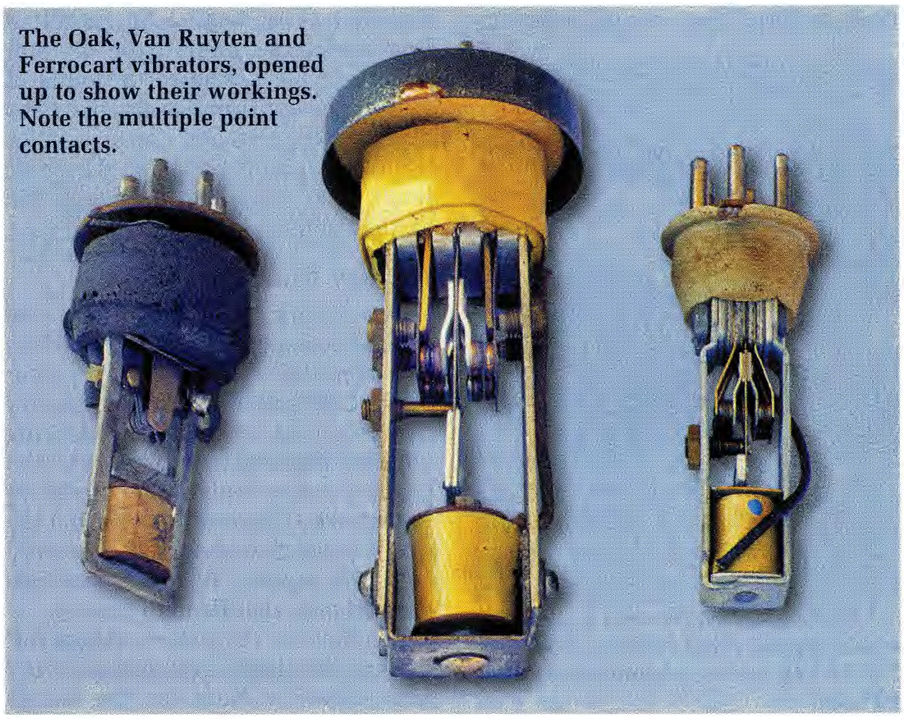
drop to the vibrator supply must be minuscule for efficient operation, so no iron-cored filter choke is fitted to this line.

Note also that the current drawn by the supply is quite variable and "peaky" over each cycle that the vibrator goes through. As a result, capacitor C38 (500μF) is fitted to smooth the voltage at the supply input so that the voltage does not sag when high current is being drawn.

The filament line requires effective filtering and bypassing for the receiver to work correctly. As already mentioned, CK5 and C43 ensure that almost pure DC is fed to the 1L5G valve. Then, on the negative side of the 1L5G filament, another electrolytic capacitor is wired to earth. This filters out any audio signals (ripple) which may appear on the filament line due to variations in the current drain when the valve is amplifying an audio signal.

If this is not done, an audio signal will be present on the filaments of all the other valves in the receiver and this will cause many strange effects. Capacitors C34 and C35 bypass any RF signals to earth, just as a bypass capacitor fitted to the cathode of an AC valve does.

The HT line also has filtering to remove the vibrator ripple voltage (hum, if you like) from the receiver HT supply. This is achieved using C39, CK4 & C28. This filter network is virtually the same as that used in AC receivers of the same era.



The Oak, Van Ruyten and Ferrocart vibrators, opened up to show their workings. Note the multiple point contacts.

Mechanical noise

Along with the electrical noise, it was also important to remove the mechanical noise of the vibrator itself. As a result, vibrators were manufactured with internal resilient rubber mounts at the upper end of the vibrator case, along with rubber mounts at the base (see photo). The vibrator was then mounted in a 4, 5, 6 or 7-pin valve socket which was usually installed on a resilient mount (eg, the HMV 2V vibrator supply had its vibrator installed on a rubber-mounted socket, while the case was enclosed in a rubber sock).

The supply enclosure was then often mounted on grommets and attached to the chassis with earthing only at one point for interference suppression purposes. The mechanical noise is virtually non-existent when all of this is done. However, not all of these soundproofing measures were used (or were necessary) in all supplies.

How the vibrator works

Let's now take a close look at the circuit of the HMV 268 power supply shown in Fig.1. As shown, the +6V rail from the battery is applied (via CK3 & CK1) to the centre-tap of the primary of the vibrator transformer (T2). It is also applied to pin 3 of the vibrator.

From pin 3, the current flows down through the reed drive coil, through the top set of points and finally through the reed to earth via pin 6. All other sets of points are initially open. The current through the coil causes it to become an electromagnet which attracts the reed to the left.

As a result, the moving reed makes contact with points 1 and 2 and so these two points are earthed.

At the same time, the reed drive contacts (at the top of the vibrator) separate and the magnetic field collapses. The reed then reverses direction, contacts 1 & 2 now separating from the reed contacts. The reed then continues to the right, making contact again with the reed drive point and also with contacts 4 & 5 which are now earthed via pin 6.

The current through the vibrator coil once again causes the reed to reverse to reverse direction and contacts 4 and 5 separate from the reed points. The reed then continues on to break the coil current and make contact with contacts 1 & 2 again and so this cycle is repeated for as long as voltage is applied to pin 3.

The frequency and amplitude of the springy reed is governed by two factors: (1) its natural frequency of vibration and (2) the setting of an adjustable drive point. This adjustment can be seen on the side of the vibrator frame (V5124). In practice, the frequency of operation of vibrators varies with the make and its intended purpose. Most radio receiver types operate at 100Hz or 150Hz. However, the Van Ruyten vibrator operates at 50Hz, as it is usually used in a 32V DC to 240V 200W AC mains output supply.

Increasing the voltage

OK, let's now take a look at how the low voltage DC is increased to a much higher DC voltage in a vibrator supply.

As discussed above, when the reed moves to the left, contact 1 is connected to earth and this in turn earths one side of transformer T2's primary winding. As a result, current flows via the centre tap of the transformer and through the winding to earth via pins 1 & 6 of the vibrator. The current builds up for a short time and then the vibrator points open again and the current ceases.

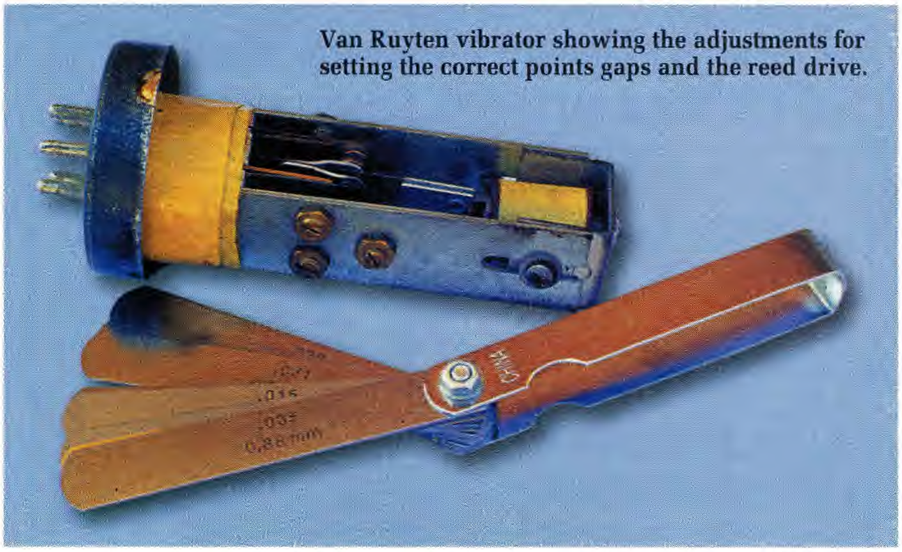
When the reed contacts reach the opposite (righthand) side, the righthand end of the transformer's primary winding is earthed via pins 5 & 6. As a result, current now flows is this half of the transformer primary to earth (ie, in the opposite direction). This cycle is then repeated, so that the 6V supply is alternately "switched" across each half of the transformer primary.

The transformer has a step-up ratio of around 1:25 and so the secondary voltage will be around 150V across each half of the secondary winding. This alternating voltage is now recti-

Photo Gallery: Philips Model 2510 Consolette (circa 1929)

Liveried in mottled red and black, the Philips Model 2510 consolette comes complete with a speaker cabinet that, with its imitation drawers, is reminiscent of an Art-Deco writing bureau. The "trunk" on top is steel-framed with timber inset panels and houses a 5-valve TRF receiver. This has a hinged lid and the escutcheon features a celluloid viewer through which the drum dial is read. The tuning and volume controls were situated at either end of the set.

(Restored by Maxwell L. Johnson, Tasmania; photo by Ross Johnson).



Van Ruyten vibrator showing the adjustments for setting the correct points gaps and the reed drive.

fied and this is done using two extra pairs of contacts in the vibrator.

As shown in Fig.1, the vibrator earths the lefthand end of the transformer secondary in synchronism with the lefthand end of the primary - ie, via contacts 2 & 6. Similarly, it earths the righthand end of the secondary in synchronism with the righthand end of the primary, this time via contacts 4 & 6. As a result, the output from the transformer (taken at the centre tap) is rectified and this rectified DC voltage is then fed to the LC filter network (C39, CK2, C41, CK4 & C28) to derive a nominal 135V rail.

In practice, however, the secondary contacts are slightly staggered, so that they close and open a short time after the primary contacts. So why was this done?

The answer is that when contact 1 makes contact with the reed, T2's primary winding starts to draw current. At the same time, the secondary will have little or no voltage across it. This means that if contact 2 made contact with the reed at exactly the same time as pin 1, there would be no induced voltage across the secondary. Furthermore, if C39 were charged, it would discharge back through T2's secondary and pin 2 of the vibrator to earth.

The same situation applies if contact 4 were to make contact with the reed at the same time as contact 5. This is clearly not what we want and the result would be a lot of sparking at the secondary contacts.

To eliminate this problem, the secondary contacts are adjusted so that they do not close until the voltage developed across each half secondary winding has risen to near its peak. This will be slightly greater than the voltage across C39. As a result, when the secondary contacts switch, very little current flows through them and this eliminates the sparking.

In practice, the timing is controlled by the difference in the gap between the primary and secondary points. In a typical Oak synchronous vibrator (V5124), the primary points gap is 0.003 inches, while the secondary points gap is 0.005 inches.

Buffer capacitor

Now we come to the buffer capacitor. In the HMV 268 circuit, it is wired across the entire secondary winding and is a 5nF (.005μF) capacitor rated at 2000V (C37). Note that the voltage rating is important, as transient voltages much higher than the nominal output voltage of the supply are developed when the primary vibrator points open.

In other circuits, the buffer capacitor may be wired across the primary, or across both the primary and the secondary in some instances. Another variation is to use two capacitors, one across each half of the primary or secondary winding. In some cases, a low-value resistor is wired in series with the buffer capacitor.

The value of the capacitor depends on just where it is wired into the circuit and the inductance of the primary or secondary winding. In operation, the buffer resonates the transformer at approximately the frequency of the vibrator operation. As a result, the vibrator will have minimal sparking at the contacts and the current drain without a load will be greatly reduced.

Servicing vibrator supplies

Servicing vibrator power supplies can be divided into two parts: (1) overhauling the mechanics of the vibrator itself and (2) overhauling the associated electronic circuitry.

The first job is to service the vibrator points and that involves disassembling the vibrator. Unsealed types can easily be dismantled. In the case of the Oak vibrators, it is necessary to first desolder the lug at the side of the base and then lever out the circlip. It's then just a matter of wriggling the base so that the internal assembly can be withdrawn from the case.

A somewhat more brutal method needs to be used with Ferrocart vibrators. In one of the photographs, a pair of side-cutters can be seen near the base of the vibrator. The side-cutters are used to peel the rolled in edge of the metal can away from the base. Once this is done, the vibrator can be slid out of its case.

Of course, this mucks up the nice tidy fold so that it looks slightly mutilated when the vibrator is later reassembled. However, there's not much choice if you want to restore this type of vibrator. It obviously wasn't designed to be serviced but replacements are not easy to obtain.

Once the vibrator has been dismantled, the first job is to check that the reed coil has continuity. Obviously, there's no point in going further if this is open circuit. If the points are not too badly pitted, they can be cleaned using some very fine wet and dry paper or by using a contact cleaner. Push them lightly together while running the paper between them, until the faces are smooth and shiny. Wash out any muck with methylated spirits and check that there is no corrosion on the points, as this can stop them from making good electrical contact.

If the points are in poor condition, an automotive points file is worth a try. Make sure that you keep the file parallel to the faces of the points and be careful not to bend the points further apart during this process.

A vibrator in good condition will start and run on a voltage that's about 2/3rds of its normal running voltage. In addition, a 6V vibrator that has an independent reed drive system (eg, the Oak synchronous types) can be

A pair of side cutters can be used to peel back the crimped edge of the Ferrocart M437 6V non-synchronous vibrator so that it can be removed from its case. By contrast, the Oak vibrator at right is opened by removing a circlip and desoldering a solder lug.

used in a 12V or 32V system if a suitable dropping resistor is placed in series with the reed coil. A 12V type could also be used on 32V using the same technique, while some 32V Operatic receivers used a 24V vibrator.

Next, it would be a good idea to check the resilient mounts inside the vibrator. The rubber socket at the end of the case is usually OK but the rubber around the base may have deteriorated. If so, it's a good idea to disconnect the leads to the plug and slip some flexible insulated sleeving over them before resoldering them. Make sure that the solder doesn't get down into the flexible braided lead during this procedure.

Once this has been done, pack up the space alongside these braided leads with foam plastic to retain the resilient mount effectiveness.

It isn't a bad idea to run the vibrator pack with the set disconnected and the cover removed so that you can check for sparking and correct general operation. This should be done particularly if the output voltage is low on load. However, don't do this until the buffer capacitor has been checked and if necessary, replaced.

In some cases, it may be necessary to bend the fixed points closer or further away from the vibrating points to improve operation. This can be done using long-nosed pliers (without power applied, of course). Be sure to adjust the points so that they remain parallel with each other.

The reed drive adjustment (if fitted) may also need to be altered. An oscilloscope is desirable so that you can check the check the various waveforms around the transformer after making adjustment but is by no means essential.

Note that the gaps between the points for the Oak synchronous vibrator are 0.003 inches for the primary points and 0.005 inches for the secondary points. By contrast, the Ferrocart non- synchronous vibrator has a spacing of 0.008-inch, while the Van Ruyten is spaced at 0.012 inches. A set of automotive feeler gauges similar to those shown in one of the photographs is necessary to accurately set the gaps.

Even without feeler gauges, it's possible to adjust the points so that the vibrator operates satisfactorily. However, always make sure that the secondary contacts are spaced wider than the primary ones on a synchronous vibrator.

With the Oak and the Van Ruyten units, the reed drive can be adjusted by shifting the position of the fixed point for the reed coil. Experiment as necessary to see what effect this has on the "vigour" of the vibration (the more the better). Don't adjust the other points until the reed is vibrating correctly.

Checking the electronics

Checking out the electronic circuitry is straightforward since there are only a few parts involved. The first step is to check all the wound components (inductors and RFCs), although they are usually OK. That done, you should check all the paper and electrolytic capacitors, replacing any that appear to be defective.

One of the most critical components is the buffer capacitor. It should be checked with a high voltage tester for leakage and should also be checked for capacitance. If you don't have the necessary equipment to check this capacitor, just replace it if the supply draws a high current when there is no load.

A typical 6V battery set vibrator supply should draw about 0.8A when connected to a set using 2V valves. By the way, high-voltage capacitors suitable for buffer use are often available from TV parts suppliers (eg, WES Components, Ashfield, NSW).

Summary

Many vintage radio restorers don't feel confident about dealing with vibrators and vibrator power supplies but most can be serviced relatively easily. Vibrator radios are well worthwhile collecting – they are not all that common and are another important part of our radio heritage. **SC**