VINTAGE RADIO

By JOHN HILL

A look at high tension filtering

Valve radios require a high tension DC power supply for the valve plates (anodes). This high tension supply is a frequent source of problems & must be carefully restored.

Most mains-operated valve radios obtain high tension DC using a transformer and rectifier valve (usually full-wave). However, the DC output from such a setup has a high ripple content (at 100Hz from a full-wave rectifier) and must be filtered before it can be used to power a receiver.

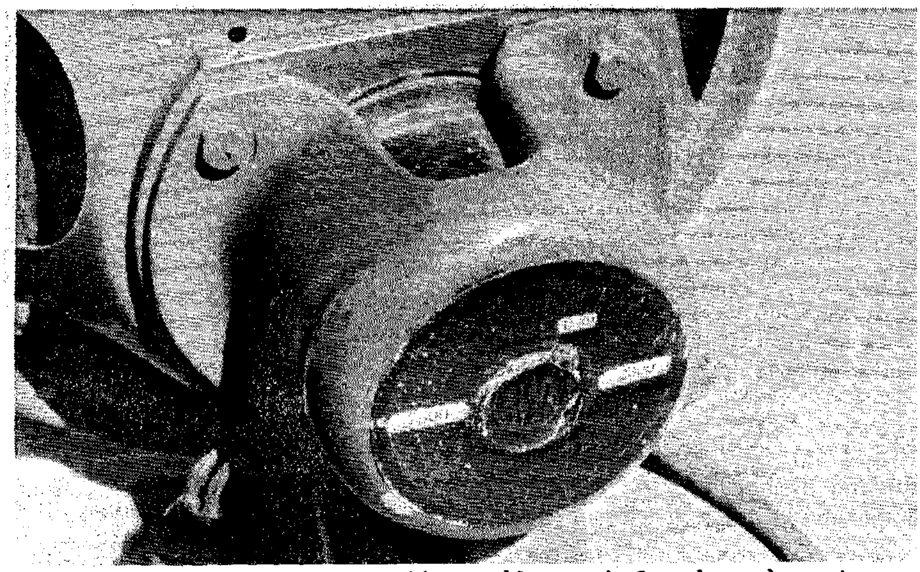
Inadequate filtering will produce a 100Hz hum in the audio output. While low levels of hum are tolerable, high levels are not and the hum must be suppressed as much as possible.

High tension (HT) filtering can be achieved in several ways and usually involves either chokes (inductors) or resistors, and electrolytic capacitors. Let's take a look at some of the methods used.

The most common high tension filtering arrangement used in prewar receivers is the filter choke type – see Fig.1. This filtering arrangement is very effective and leaves little to be desired. High tension supplies designed around a filter choke have quite low hum levels. The inductance of the filter choke opposes any change in current flow, whether this change be an increase or a decrease.

High tension filter chokes come in two physical forms. Either the field coil of an electrodynamic loudspeaker can be used or it can be a separate unit bolted to the chassis at some convenient place. This latter looks like a small transformer.

In the first case, the cost of a choke is saved by making the field coil of the loudspeaker do double duty. A filter choke is nothing more than a large coil of fine copper wire wound on an iron core. In the case of a field coil, the iron core, when energised, becomes the speaker magnet. At the same time, the field coil filters the power supply current. Electrodynamic loudspeakers were used on most early AC receivers.



This photo shows the field coil (inside metal housing) of an electrodynamic loudspeaker from the mid-1930s. The field coil played a dual role: (1) it was used as an electromagnet for the loudspeaker; & (2) it was used as a high tension filter choke.

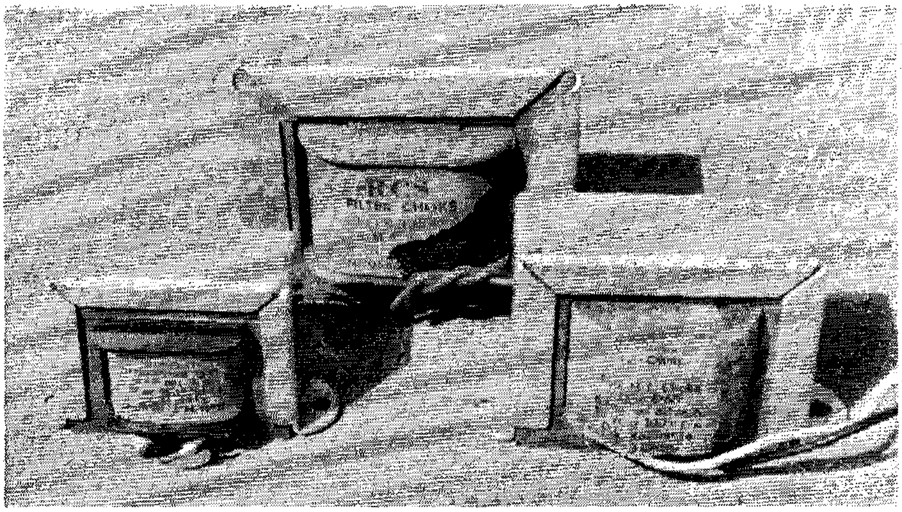
Hum problems

This arrangement does have one disadvantage, however. Because the speaker field is being energised by only partially filtered current, a small amount of hum can be generated in the speaker itself. This was overcome by fitting the speaker with a "hum bucking coil" in series with the voice coil. It was magnetically coupled to the field coil and cancelled out most of the hum generated in this manner.

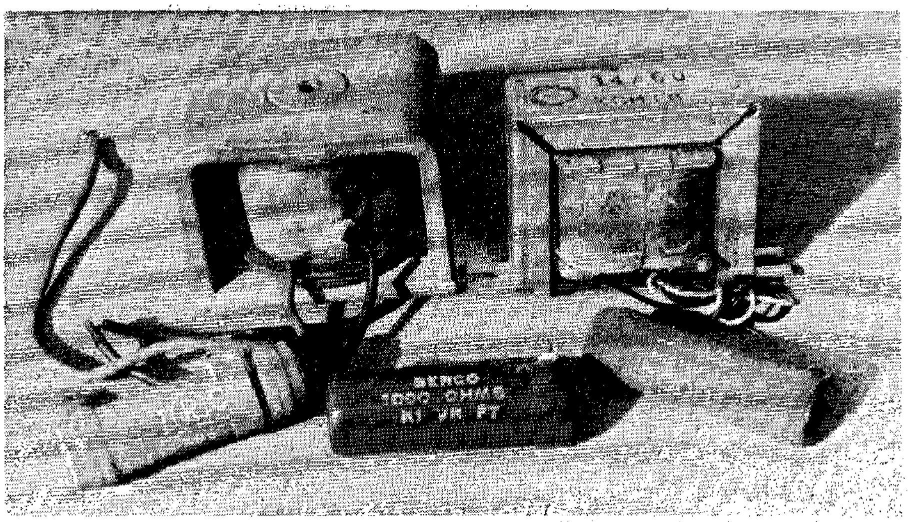
Speakers using permanent magnets instead of a field coil were also available in pre-war sets. However, they required very large and expensive magnets, and were not very efficient. They were mainly used with battery-operated sets.

That situation changed after about 1948 when much more powerful magnets became available – as a result of wartime research – and permanent magnet (permag) speakers were subsequently used in all types of receivers. Because a field coil was no longer used, these receivers required a separate high tension filter choke.

Whether the filter choke is a speaker field coil or a separate unit, its function is much the same; it opposes any change in the current flowing through



A selection of high tension filter chokes. These chokes perform the same function as a field coil in smoothing the high tension supply & are usually mounted at some convenient spot on the chassis.



Either a field coil, a choke or a resistor form the central component of most high tension filters. In conjunction with high voltage electrolytic capacitors, they provided adequate HT filtering for most valve radio receivers.

it. Effective though it is in this role, it is not sufficient by itself. But when large electrolytic capacitors are connected from each end to ground, the result is a smooth DC current.

Capacitors have the ability to store an electrical charge and this is their main role in a high tension filter. By taking on a charge when the rectifier voltage rises and giving up that charge when the voltage drops, capacitors supplement the filter choke constant-current action by tending to maintain a constant voltage.

In some applications, where heavier DC currents are required, a second filter choke and an additional electrolytic capacitor can be added to produce an even smoother supply. As far as domestic radios of the four or five-valve type are concerned, this extra filtering stage is unnecessary.

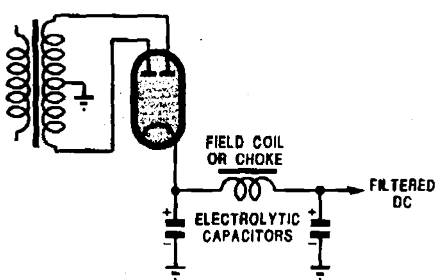


Fig.1: a typical HT power supply for a valve radio receiver. In some circuits, a resistor is used instead of a choke or loudspeaker field coil. HT supplies are a common source of trouble.

It must be remembered that an additional choke will also lower the output voltage and thus needs to be designed into a piece of equipment rather than added as an afterthought.

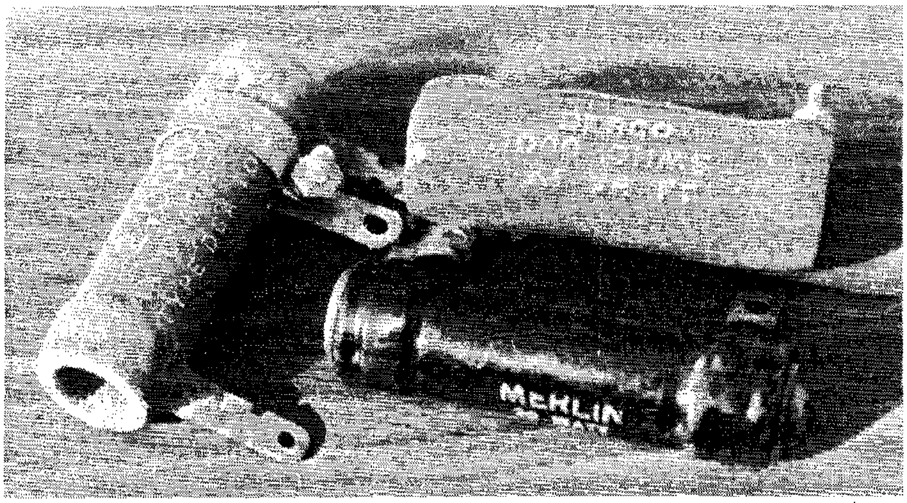
Capacitor values

The size of the electrolytics also has an effect on the effectiveness of the filter. Hum can often be reduced simply by installing larger capacitors, particularly on the output side. A larger output capacitor also gives better regulation.

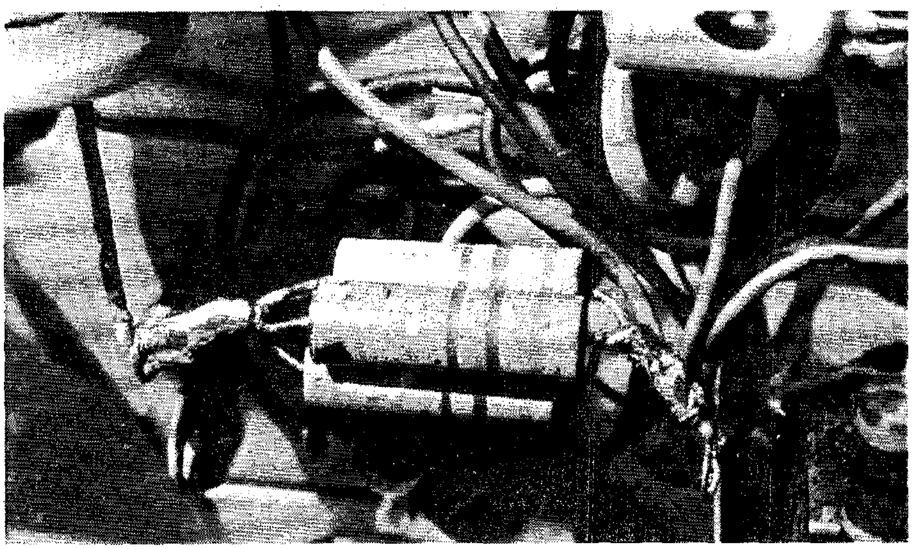
However, if one cares to check the valve specification manuals, recommended maximum capacitor values for the input side of the filter are usually listed for various rectifiers. It is inadvisable to fit larger than recommended capacitors in this position. The objection is the excessive peak current that these will draw through the rectifier. Large input capacitors should not normally be necessary for hum free results.

If larger input capacitors do need to be fitted, limiting resistors should be added in series with the rectifier plates to protect the valve. The values of these resistors are usually listed in valve characteristics manuals.

If a filter system incorporates a



These 20W wirewound resistors can dissipate quite a lot of heat and should be mounted well away from any heat-sensitive components. Note that the resistor on the left is adjustable.



This receiver uses three parallel 1W resistors in its high tension filter. They are used in conjunction with two 24µF electrolytic capacitors to provide a well-filtered HT rail for the valve anodes.

speaker field coil, 8µF electrolytic filter capacitors would typically be used.

Troubleshooting

A distinct hum in an old receiver is very often the result of electrolytics losing their capacitance. Replacements will usually solve the problem. Another cause of hum could be the bypass capacitors across either of the grid bias (cathode) resistors.

Electrolytics with electrical leakage problems are also a matter for concern, as they can have two effects on a high tension filter. Leakage will not only lower the filter's output voltage but will also overload the rectifier valve and shorten its life. However, the worst aspect of high tension leakage is the fact that it often overloads the choke itself and results in a burnt-out winding.

By the 1950s, radio manufacture had become very competitive and more and more receivers where being made to a price rather than to specifications. As a result of this cost cutting, the overall number of parts in many receivers was reduced to a bare minimum. One of the components found to be dispensable, by careful circuit design, was the high tension filter choke.

The choke was replaced with a resistor and larger electrolytics used to keep hum at an acceptable level. Many of these sets have filter capacitors ranging from 16µF to 32µF. But the main trick with these designs was to take the high tension for the output valve directly from the input side of the filter. Since there is no amplification following this stage, the hum remained within acceptable limits.

Only the current for the front end of the receiver passes through the remainder of the filter system. And, since this current is relatively small, it can be quite adequately filtered by the second electrolytic. The resistor is not a filter component as such but serves mainly to isolate the second electrolytic from the heavy current demands of the output stage, so that it serves only the front end.

The resistor used in these filters is often made up of two or three carbon resistors connected in parallel, in order to provide an adequate wattage rating. Typically, the resistance varies from 1.5kΩ to 10kΩ and is rated at around 2-3W for small receivers.

So while a high tension filter that uses a resistor may seem to be a crude alternative, it is reliable, effective and does have some good points.

Filter systems employing resistors rarely gave trouble. Field coils and filter chokes, on the other hand, were common breakdown items and they could be costly to repair or replace. If a high tension short circuit causes a filter resistor to blow, it is both cheaper and easier to repair than a loudspeaker with a burnt out field coil. So its use makes a receiver a little more trouble-free over a long period. What's more, most people would never know the difference when listening to it.

Field coil substitution

Using a resistor type filter system as a substitute for a choke system becomes a tempting proposition when a vintage radio repairer is faced with a serious loudspeaker problem. An open field coil is not the only thing that can go wrong with an old speaker, however. The speaker cone can be out of shape, split or completely in tatters.

In such instances, the easiest way out is to fit a "permag" speaker. When doing so, a suitable substitute for the field coil/choke must be made and a resistor may be the logical way to go. Better still, a combination of choke and resistor can be used, provided they add up to the same DC resistance of whatever it is they are replacing.

Some old radios draw a fair amount of current through the field coil and this needs to be taken into account when selecting a suitable resistor. A

1930's set with six or seven valves can draw about 60mA of high tension current and this requires a high wattage wirewound resistor to handle the load. I prefer something with a 20W rating – one of those big hollow resistors with a brass core that can be bolted to the chassis.

This convenient mounting method also helps the resistor to dissipate some of the heat, since the chassis can act as a heatsink.

Field coils and high tension chokes should not run hot. Their normal working temperature is moderately warm; hot is abnormal and indicates a fault somewhere.

An average 5-valve receiver will draw approximately 50mA if it is operating correctly. If the current consumption exceeds that (eg, 60-65mA) there will be a considerable increase in the operating temperature of the central filter component, whether it be a choke, a field coil or a resistor. Overloads of this nature can eventually lead to the over-stressed component breaking down.

Simply touching a field coil or choke after a half-hour operating period will give a reasonable indication of working temperature (but make sure that the receiver is unplugged first)! Connecting a milliammeter in the high tension line will give an accurate assessment without the half-hour wait.

Possible faults

If high tension current is excessive, it can be caused by a number of factors: (1) a faulty valve could be drawing too much current; (2) there could be electrical leakage through the high tension capacitor on the output side of the filter; or (3) the receiver could have a grid bias problem whereby the output valve draws more plate current than it should. A defective coupling capacitor is a prime suspect with this particular problem. But whatever the cause, it needs to be corrected to avoid damaging expensive components.

In summary, the high tension filter is an important part of any mains-powered valve receiver and it requires periodic maintenance to keep it in good working order. While the physical arrangement differs from set to set, they all serve the same function – to produce a smooth DC supply. A ripple free high tension current is essential for hum free operation. **SC**