Vintage Radio

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Performance improvements for the Hotpoint Bandmaster J35DE console radio

The two previous articles on this set dealt with its restoration. The aim was to make the set work as it did originally. We now look at what can be done to improve the performance in the light of design knowledge some 60 years later.

IF YOU ARE ONE of those who only wish to restore a radio as close as possible to the original, this article is not for you. We can understand those who strive to produce the vintage radio equivalent of the Concours d'Elegance but as we have pointed out in the past when discussing many valve radios, they often had design faults and unfortunate compromises.

OK, what was wrong with the design of the Hotpoint? At the time it was produced it would have been regarded as a great set.

The most serious fault is the attenuation of higher audio frequencies due to the tight selectivity of the intermediate frequency stage. Selectivity refers to the "sharpness" of tuning in a radio. This was common to sets manufactured by big companies and built by hobbyists in the 1940s and 1950s.

The usual practice was to have the IF (intermediate frequency) at 455kHz and one IF valve stage. Tuned transformers, each with two circuits, were used, one between the mixer and the IF amplifier and the other between the IF amplifier and the diode detector.

Radios intended for use in country areas sometimes had two IF amplifier stages and three IF transformers – a total of six circuits tuned to 455kHz.

They were great for picking up distant stations but due to the severe attenuation of the high audio frequencies, they always sounded very "mellow". These days we would simply regard the sound quality as muffled.

In order to appreciate why this happens, we need to look at the nature of the signal transmitted by the radio station.

Say the station is transmitting with a carrier at 1MHz (1000kHz) and it is modulated with a tone of 5kHz. Then, the station is actually transmitting three separate frequencies: 995kHz, 1000kHz and 1005kHz. If you put in a filter which passes the 1000kHz but attenuates the 995kHz and 1005kHz frequencies, they will be reproduced at a lower level.

Spectrum analysers and other sophisticated test instruments were not generally available in design laboratories in the 1940s and 1950s and many engineers were a bit hazy about the idea of sidebands. In the 1960s, single sideband (SSB) transmission became

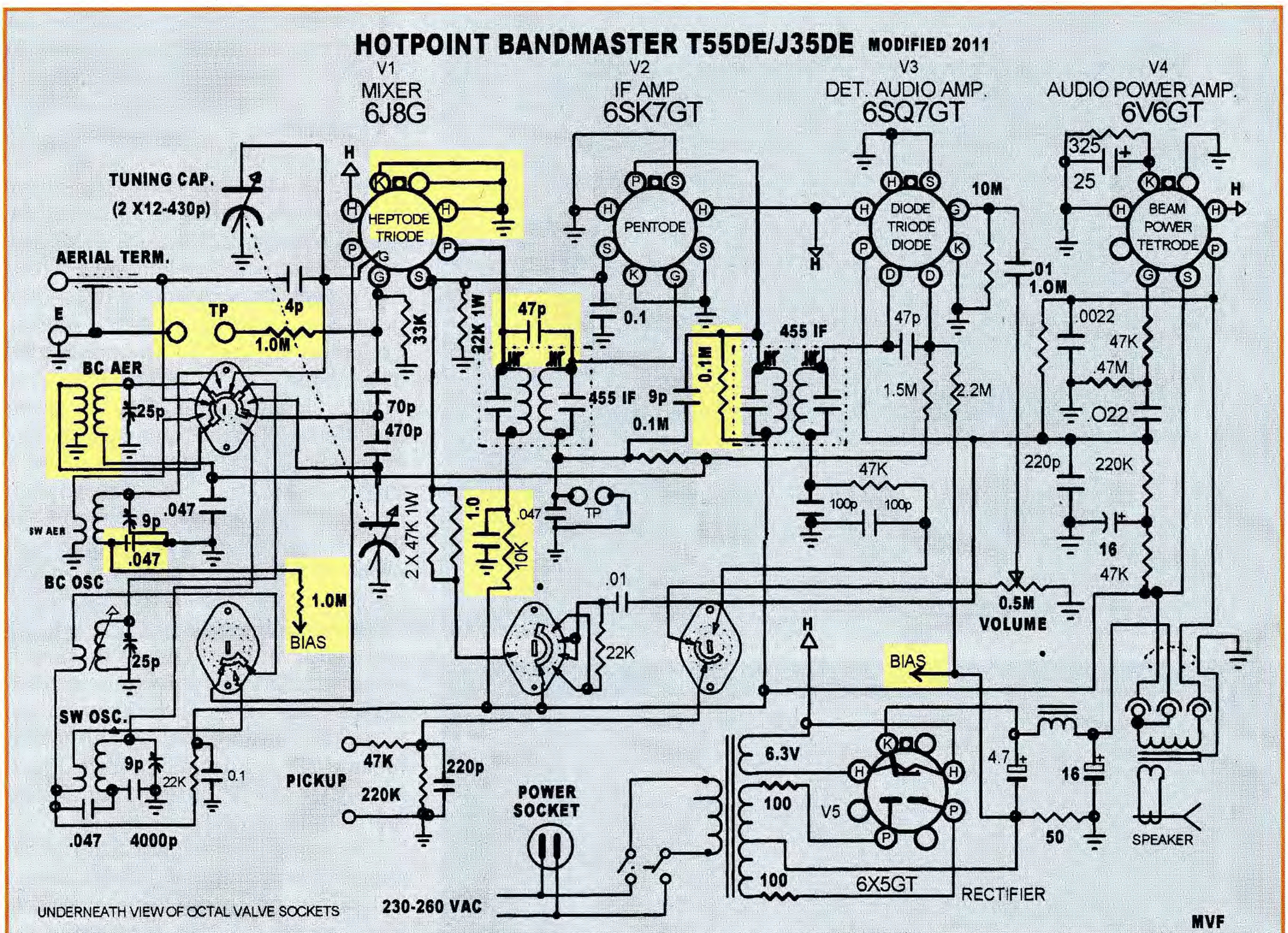

Fig.1: while some vintage radio restorers may regard this as sacrilegious, this diagram shows how the circuit can be modified to improve its performance. Specifically its audio bandwidth can be widened and the gain increased.

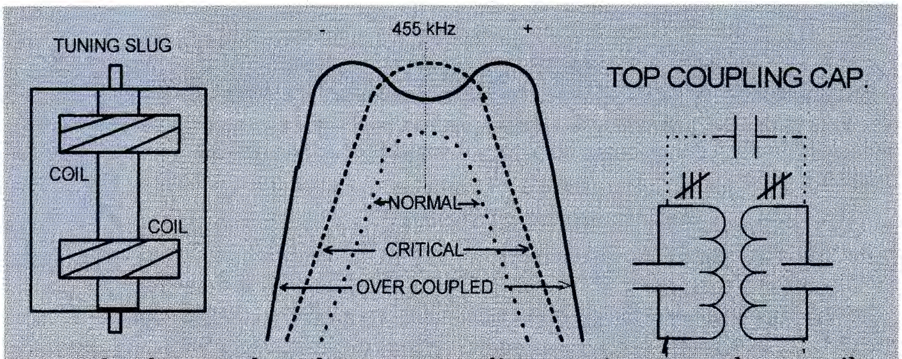

Fig.2: this diagram shows how a top-coupling capacitor across the two coils in an IF transformer can be used to increase the audio bandwidth.

the standard for high-frequency communication circuits and designers began to realise that you could survive with one sideband only. But that's another story.

If people wanted a wider audio response in the early years, the solution was to have a TRF (tuned radio frequency) receiver. Many of these were built by hobbyists from designs in popular magazines. They usually had three tuned circuits and two valve amplifying stages, followed by a detector.

The difficulty was that they were only suitable for areas close to strong stations. And if there were other stations close in frequency to the one you wanted, they would often break through. In other words, they had poor selectivity.

A better solution

A better solution is to design the 455kHz amplifier so that it will pass the higher frequency sidebands. How high? Currently, in Australia, broadcast stations are separated by 9kHz. The authorities have taken great care in allocating channels, in a geographical sense, so that there is little chance of local interference from adjacent channels. In theory, a filter which had a level response centred on 455kHz and maybe 20kHz wide would be OK.

But how to make such a filter? We would have to get the old engineer's slide rule out and do some sums but such a filter could easily have 16 inductors with precisely defined Q factors. In addition, the losses through the filter would certainly make it necessary to have another amplifying stage – not practical.

How about a compromise? There is a way that the response to higher audio frequencies can be improved. It involves changing the coupling between the windings of at least one

The rather complex dial stringing arrangement which was pictured last month is necessary to support the long pointer at top and bottom.

Conveniently, the dial stringing arrangement is shown on the back of the dial assembly itself. Without this diagram, it would be impossible to figure out the dial cord path.

of the IF transformers. A little about how coupled tuned circuits behave will make the idea clearer.

The two windings on a 455kHz IF are usually wound on a small diameter former and placed in a shielded can one above the other (see Fig.2). They are each tuned by fixed capacitors and a ferrite or iron-core slug which can be moved up and down inside the winding. The windings are carefully placed so that when one is adjusted it does not affect the other. This is called under coupling and is how most IF transformers are arranged.

If the windings are brought closer together, the transfer of energy from the primary to the secondary will increase until a peak is reached. Bringing the windings closer still then actually reduces the energy transferred at the 455kHz centre frequency and boosts the response on either side. This is illustrated in Fig.2 with the curve labelled "Over Coupled" and gives a clue as to how the response can be widened.

Top coupling

It would not be easy to increase the coupling between the windings by moving them in an existing set but the same result can be achieved by connecting a small capacitor between the tops of the windings. The degree of over-coupling depends on the value of the capacitor and we have done some practical work to see what can be done.

A 47pF capacitor connected across the 1st IF transformer improved the audio response of the Hotpoint at 5kHz by +6dB; a very worthwhile improvement for such a small modification.

How do you go about choosing the best top-coupling capacitor in your particular set? It's a fiddly operation but with care, the best value can be determined using only a multimeter. You will have already peaked the IF coils.

Connect the multimeter to the test point and carefully tune to a station, preferably at the low-frequency end of the band. Use an external aerial so that the signal is reasonably strong and not affected by body movements. The meter should indicate -3V or more.

Next, solder a low-value capacitor (eg, 22pF) across the tops of the IF transformer winding. There will probably be a slight increase in the meter reading.

Now try larger capacitors: 33, 47, 68 and 100pF in turn. One of these will actually result in a lower meter reading and this is the correct one to use to get the required over-coupling and broader IF response shown in Fig.2. Note that the IF tuning slug adjustments must not be altered

The value of capacitor for a given degree of coupling could be calculated if the inductance, the initial coupling and Q factor of the IF transformer are known but it is much easier to determine by experiment.

HT modification

A slight complication now arises: the hum on the high-tension (HT) line is now applied to the grid of the IF amplifier and the AGC-detector lines via the top coupling capacitor. This makes it necessary to put in a resistor/capacitor filter to feed the high-tension to the plate of the mixer valve.

The primary winding of the second IF transformer will usually have a high Q which will fill in the dip in the response of the over-coupled first IF but in our case it also contributed to the sideband attenuation. A 0.1MΩ resistor wired across the primary gave the optimum overall IF response.

The improvement is well worthwhile and the resulting overall frequency response of the set is about -3dB down at 5kHz instead of the original -10dB (if you want the original "mellow" tone, the function switch is still available).

The modification makes it easier to understand speech and enjoy music.

One curiosity of the Hotpoint J36DE set is that the loudspeaker is installed with 10mm spacers between its frame and the baffle. We're not sure why this is so but suspect that it was done to reduce the bass response because the set does have audible hum. Alternatively, the designers may have been concerned about acoustic feedback. As a consequence of this odd installation method, the entire speaker cone had come away from the speaker frame and had to be glued back in place.

However, it certainly does not make the set comparable with modern FM or digital receivers in terms of distortion or frequency response.

Modifying the converter

Another quirk of the original design of the Hotpoint is the operating condition for the 6J8G frequency converter. The negative bias applied to the signal grid is that supplied by the back-bias resistor, through the AGC network, plus that developed across the 200Ω resistor at the cathode. It is too high. As a result, the gain available for weak signals is less than the valve can provide.

The solution is to earth the cathode of the 6J8G. This provides maximum gain from the converter and better operation of the oscillator, particularly on shortwave reception.

With the cathode of the 6J8G earthed, it is necessary to return the shortwave aerial coil to the back bias network. The added components are a 1MΩ resistor and .047μF (47nF) capacitor. This retains the original idea of no AGC on the converter on shortwave.

The overall gain of the set with the modifications shown on the circuit is actually slightly more than with the original design. The increased mixer gain and that attributable to the closer 1st IF coupling more than makes up for the losses due to the damping of the 2nd IF.

Even with the increased gain, the Hotpoint needs a reasonable length of internal or external aerial wire for good daytime reception of local stations. All glass miniature valves which became available a few years later had much higher gain. In combination with efficient ferrite rod aerials, they made external aerials unnecessary for the medium-wave band.

The original design also has a series 455kHz tuned circuit across the primary of the broadcast aerial coil. It was intended to reduce interference from airport navigational beacons. Unfortunately, it also reduces the sensitivity of the radio, particularly at the low-frequency end of the band and when a short aerial is used.

Beacons of all sort are now kept away from 455kHz so this filter is no longer necessary. It can be disabled by removing the associated 50pF capacitor.

The set works better when modified as described. It would be interesting to talk to the set's original engineer but he or she has now probably passed on to a higher design laboratory.

Increasing the audio power

Finally, the conservative operating conditions for the 6V6GT output valve are worthy of comment. A 325Ω cathode bias resistor is used with about 250V applied to both plate and screen. The optimum load for these conditions is about 7000Ω and the undistorted power output around 1W at the speaker transformer secondary (the original specification says 3W!).

Slightly more audio power can be obtained by reducing the cathode bias resistor to 250Ω and the plate load to 5000Ω but at the expense of more heat and shorter valve life. Speakers used with sets of the period were quite sensitive and 1W is enough for most situations. SC