By JOHN HILL

A look at signal tracing, Pt.2

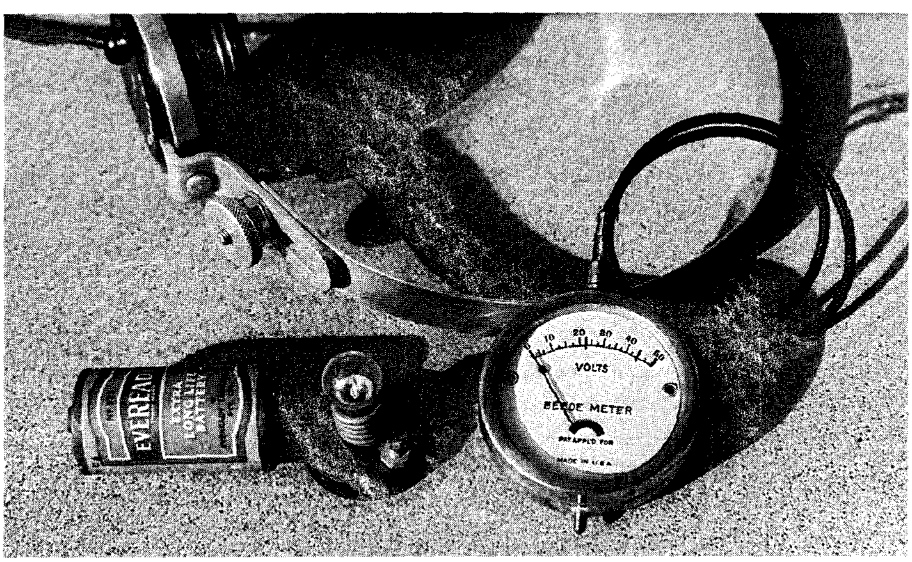
Last month's Vintage Radio described the restoration of an old Healing Dynamic Signalizer (signal tracer). This month, we will put it through its paces and use it to check a typical superhet receiver.

In the early years of radio, technicians managed with a minimum of test equipment. A torch cell and small globe for a continuity checker, plus a pair of headphones and a voltmeter would just about make up a complete test kit for the mid-1920s serviceman. In those days, receiver ailments were mainly exhausted batteries, faulty valves and open circuit audio transformers.

As receiver complexity increased so did the need for more elaborate test instruments. It wasn't long before valve testers, multimeters and other instruments were in regular use.

When fault finding, a multimeter can contribute much to the task in hand. It can be used to measure voltages, check resistor values, and to check for shorts or open circuits. It is particularly useful for tracking down open-circuits in coils and transformers.

In fact, most faults can eventually be found by using a multimeter. But it can take some time and that is something the serviceman cannot afford. Something that would find faults quickly was one of the main requirements which lead to the development of the signal tracer. This device removes a lot of the guesswork from radio servicing.



A service kit for a mid-1920s radio serviceman would consist of a torch cell and globe, a voltmeter, and a pair of headphones. As receivers became more complex, the need for better test equipment increased.

The big advantage of the signal tracer is that it can tap into the various stages of a receiver. It can check both radio and audio frequencies, amplify the signal and then play it through a speaker.

Signal tracers vary in complexity. Some are quite elaborate with multiple tuned circuits, a built-in VTVM (vacuum tube voltmeter) and a modulated oscillator to supply a steady signal source. Unfortunately, such upmarket tracers are now few and far between, and types such as the Healing are about as upmarket as vintage radio repairers are likely to find. If anyone locates one of those really good ones, then they are lucky indeed.

Typical test procedure

Enough of this wishful thinking. Let's hook up the old Healing and proceed with the proposed test. We will run through a typical late 1930s 5-valve superhet with a 460kHz intermediate frequency (IF) – see Fig.1.

But first, a check for obvious faults, such as valves not lighting or a non-operative high tension (HT) supply, should be made. An open field winding or shorted filter electrolytic would be good reason for no HT voltage. A signal tracer is best used for finding obscure faults, rather than easily recognised ones.

For the test proper, a steady signal source is required. There are two choices: a modulated radio frequency (RF) signal generator or a radio station. In this example, an RF signal generator will be used, as it supplies a uniform signal which can be varied by the generator's attenuator. The RF

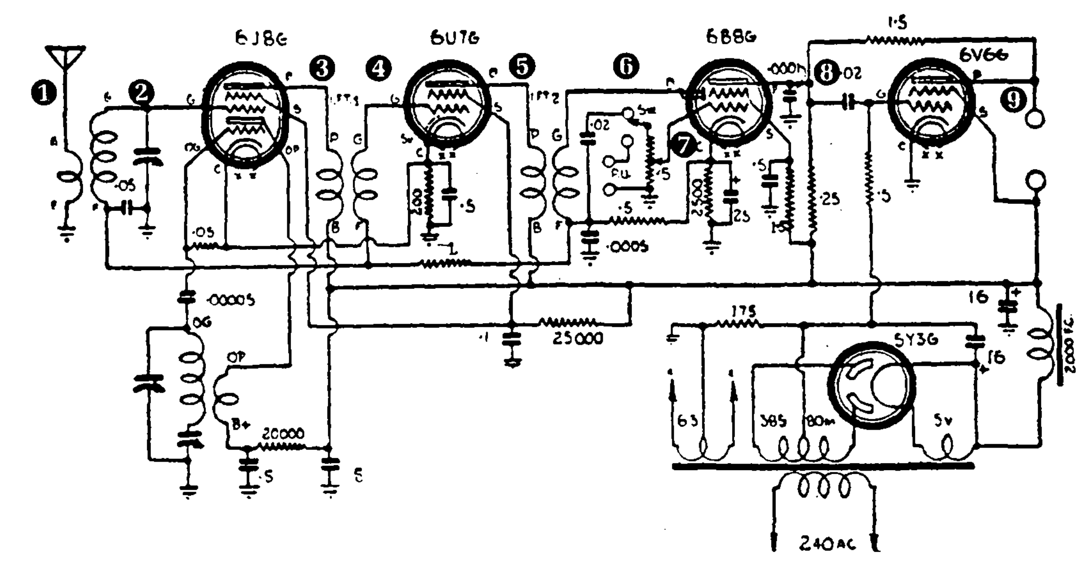


Fig.1: a typical 1930s 5-valve superhet radio circuit. The numbers marked in red correspond to the test points listed in the text.

generator is connected to the receiver's aerial and earth terminals, while the tracer's earth clip is attached to the receiver's chassis.

The next step is to set the RF generator to around 600kHz and turn the attenuator full on (ie, maximum signal output). I use 580kHz as it saves having to change frequency bands on the tracer later on in. A low frequency rather than a high frequency test signal is chosen, as it is less affected by the loading affect of the RF probe.

The tracer's RF probe is then placed on the receiver aerial terminal (point 1 on Fig.1) and, with its RF and AF gain controls set to maximum, the tracer is tuned to the 580kHz signal. The output from the tracer's speaker is fairly low during this test but can be heard to peak as the tracer's tuning dial is correctly positioned.

Failure to find a signal at this first test point would suggest a short circuit between the aerial terminal and chassis.

Next, the RF probe is placed on the converter valve control grid. A more convenient connection may be to the fixed plates of the tuning capacitor (2). The receiver should then be tuned to 580kHz, as indicated by the tracer's speaker.

Although the test signal has not yet encountered a valve, the signal at this second test point should be considerably louder than the first. The reason is that the signal is now tuned to resonance. This may vary a little from set to set, as the gain is dependent on the efficiency, or "Q", of the aerial coil.

Failure to pick up a signal at this test point would indicate a faulty aerial coil, shorted tuning capacitor, or a shorted trimmer capacitor.

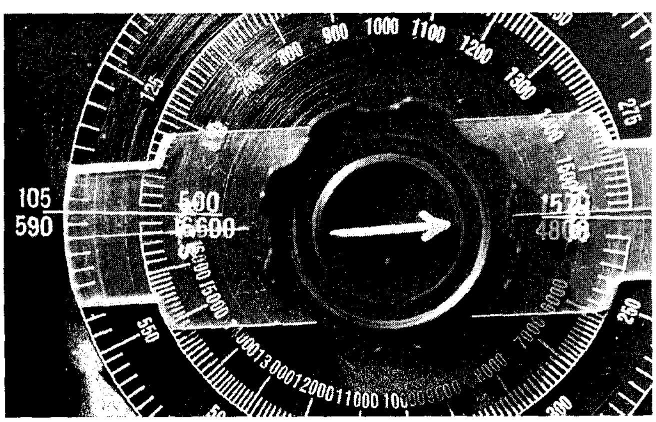
We now shift the RF probe to the next test point, at the plate of the converter valve (3). If all is well the signal will be much stronger now (due to stage gain) and the RF gain control may require backing off a little.

Retuning the receiver

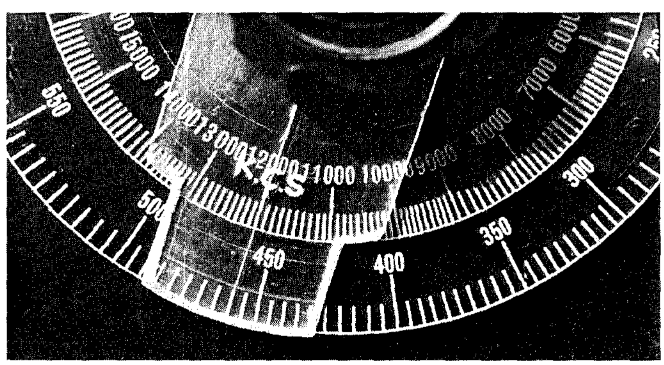
Note that when probing the first few RF test points, the receiver should be retuned each time the probe is moved. That's because the RF probe has a tendency to load the circuit and detune it slightly. However, once past the first intermediate frequency (IF) transformer, this retuning procedure is no longer necessary.

Faults frequently occur in a frequency changer stage and, when checking the plate of the converter valve, several frequencies should be present. Let's take a closer look at these frequencies.

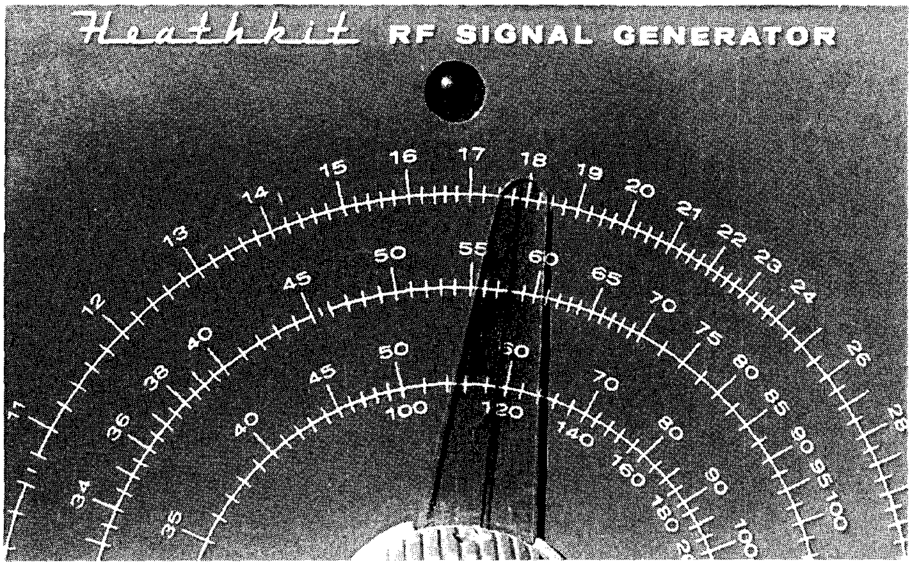
With the tracer still set at 580kHz,



As one of the tracer's frequency ranges is 220-590kHz, 580kHz is a convenient frequency for broadcast band signal tracing.



The receiver's intermediate frequency can be easily checked by first tuning to it on the tracer dial. Failure to pick up the IF at the converter valve plate indicates trouble in the oscillator circuit. The tracer dial is shown here tuned to 460kHz.



Tracing signals through a radio is easier if a modulated RF signal generator is used. This close-up view shows a Heathkit generator set to 580kHz (middle scale on dial).

the signal should be loud and clear at the plate, indicating that the stage is amplifying the signal. The set's IF signal should also be there and tuning the tracer to 460kHz will confirm its presence if the oscillator circuit is working OK.

The oscillator frequency should also be present at the converter plate and, with the receiver tuned to 580kHz, the oscillator frequency should be 1040kHz (ie, 580kHz + 460kHz). Although the oscillator is not modulated, it picks up some of the RF generator's modulation in the converter valve and can be heard softly at 1040kHz.

If there is no IF signal at the converter plate, it's a fair indication of either a faulty valve or a defective oscillator circuit. In that case, a thorough check out of this stage will be required.

Testing beyond the first IF transformer (4) with the tracer set to 580kHz will reveal no signal at all and it is necessary to retune the tracer to the receiver's IF, in this case 460kHz. The reason for this is straightforward. Although the original frequency of 580kHz and the IF of 460kHz are both present at the converter plate, only the 460kHz signal passes through the first IF transformer. If this signal is absent at the grid of the IF amplifier valve, we look for a fault in either the first IF transformer or its associated circuitry.

Three working receivers were used to check the old Healing signal tracer and, in each instance, it was found that the signal strength decreased considerably as it passed through the first IF transformer. This decrease, however, is a false condition, caused by the RF probe loading the transformer secondary and detuning it. Retuning the secondary winding while the probe was in place proved this point. As the transformer was retuned, the test signal increased accordingly.

Once again, due to stage gain, the signal level rises dramatically at the plate of the IF amplifier valve (5). If the signal is not present at the plate, either the valve is defective or a component associated with it has broken down; eg, screen resistor, bypass capacitor, etc.

Second IF stage

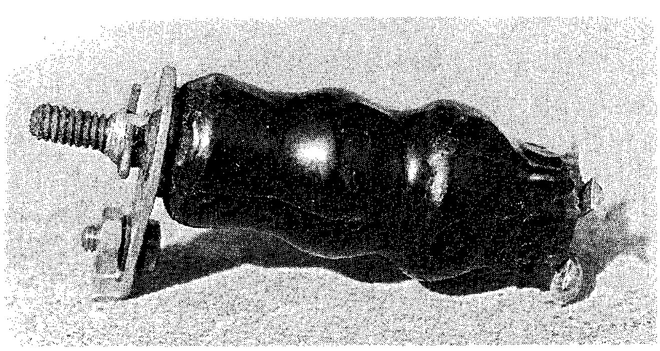
Following the 460kHz signal further, it must pass through the second IF transformer and onto the detector diode. The signal loss through the second IF transformer is not as noticeable as the first, possibly due to the loading effect of the diode.

If the signal is not present at the diode (6), check the second IF transformer windings and accompanying circuitry.

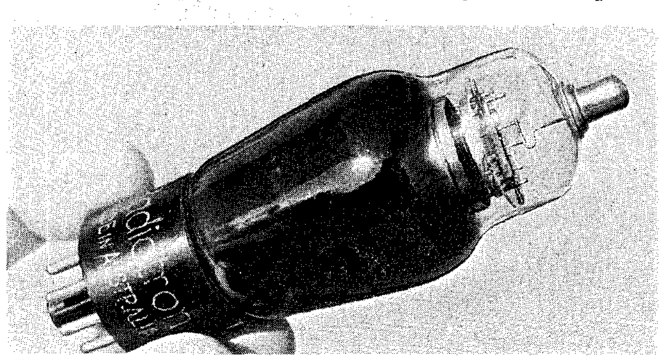
At this stage, it is time to use the audio probe. The first component the audio signal encounters after the detector is the receiver's volume control. If that control is backed off, no audio signals would be found in any of the audio stages. Place the audio probe on the moveable arm connection of the volume potentiometer (7) and rotate the control until the signal is heard. If nothing happens then an open or shorted volume control is the likely cause.

Continuing on from the volume control, the audio signal should be present on each side of the coupling capacitor (if one is used) which feeds the signal to the control grid of the first audio amplifier. There should be similar volume levels on each side of this coupling capacitor.

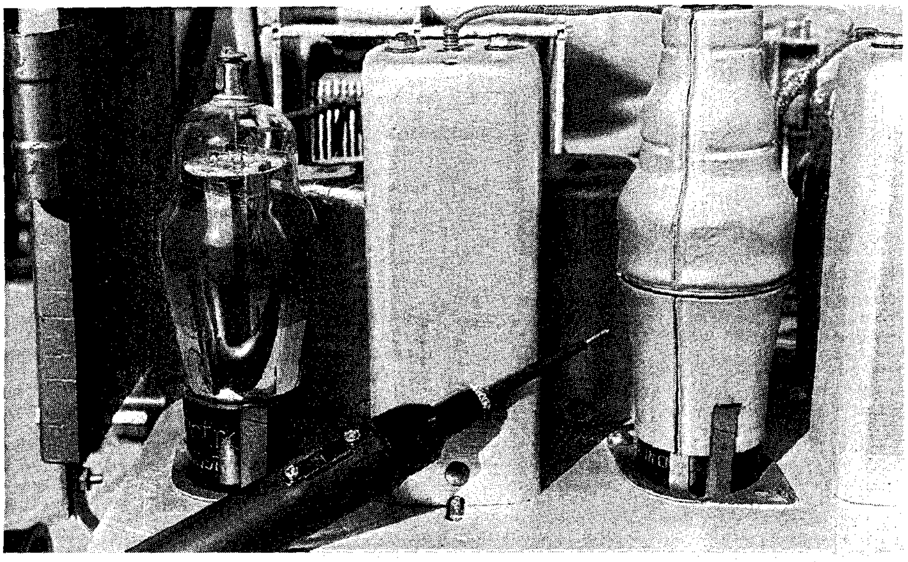
A noticeable increase in gain will be evident when the probe is moved to the first audio valve plate (8) and the AF gain control or the receiver's volume control may need to be backed off. If there is no signal at the plate,



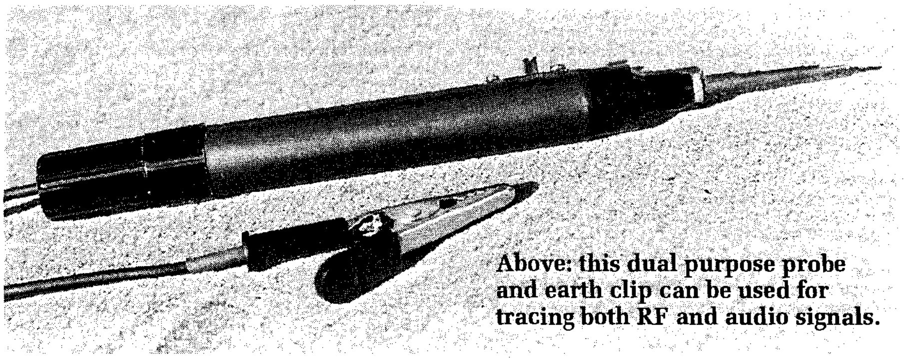
If the signal tracer fails to locate an intermediate frequency (IF) signal at the converter plate, it could well be caused by an open circuit oscillator coil.



Frequency converter valves such as the 6J8G are often the cause of non-functioning radio receivers. A lot of problems can be found in and around converter stages.



When probing the secondary of the first IF transformer, there is an apparent loss of signal strength due to the detuning effect of the RF probe.



Above: this dual purpose probe and earth clip can be used for tracing both RF and audio signals.

either the valve or its associated parts are faulty.

Again, there should be little or no volume drop when checking both sides of the coupling capacitor between the first audio valve and the output valve. But a fairly solid increase in volume should be noticed at the plate of the output valve (9).

If there is a signal at the grid of the output valve and none at the plate, then the fault could be in the valve itself or the output transformer that couples the valve to the speaker.

So that takes us through the basic process of signal tracing. Although we went through our test step by step, the job can be speeded up a little if so desired.

By probing only the control grids of each valve a lot of steps can be eliminated. Probe the grids until the signal stops, then backtrack to where it is found again. Somewhere in between is where the trouble spot must be found.

When using a signal tracer it should only take a few minutes to set up the equipment and track down the approximate location of a fault. That's the big advantage offered by a tracer – speed and accuracy! While the instrument takes a while to get accustomed to, its value as a troubleshooter soon becomes evident.

Intermittent faults

Having gone through the routine described above and grasped the broad concept of signal tracing, the experimenter is in an excellent position to embrace what is probably the most valuable feature of all. We refer to the problem of the intermittent fault and the role a signal tracer can play in tackling this type of problem.

Next month's Vintage Radio will look at this problem in greater detail and describe how to make and use a simple untuned tracer. While the untuned tracer lacks the versatility of the tuned type, it is nevertheless a handy test instrument – particularly if you have no other type. **SC**