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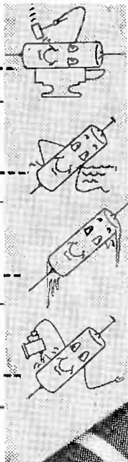

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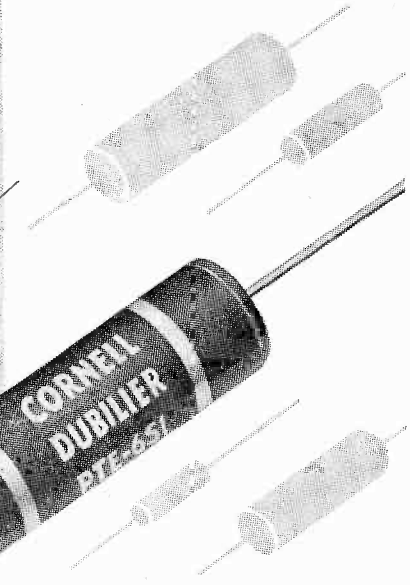

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TAKING COMPLETE RECEIVER PERFORMANCE DATA

At one time, the belief was partially justified that only engineers should bother to take performance data on radio receivers Today, however, home and communications receivers of competitive manufacture follow many varied designs and performance standards so that good practice favors keeping a case history of each receiver that goes through a service shop. The foundation for such a case history is a complete performance test which yields important information when the receiver is returned for subsequent conditioning. Furthermore, a performance test is imperative before and after an overhaul, in order to determine the benefit of repairs and adjustments. It also should be a part of the serviceman's trouble-shooting procedure, and certainly should follow each major repair job. Once the test procedure has been mastered, the service engineer will be able to handle the operations quickly in routine, and engineer and client will benefit mutually from the quantitative information obtained.

Recommended Test Program

We recommend that the serviceman check the following characteristics of an a. m.-type superheterodyne receiver in the order listed:

(1) Audio gain and sensitivity
(2) Audio power output
(3) Fidelity (frequency response) of the audio channel
(4) I. F. gain
(5) I. F. bandwidth
(6) Conversion gain
(7) Selectivity
(8) Sensitivity
(9) Fidelity of entire receiver
(10) Noise or hum level

The order of the above tests progresses backward from the loudspeaker to the antenna terminals. This is a logical procedure which serves to reveal performance defects at the proper point in the program and thus to isolate them. For instance, test 3 may show that the audio channel, as designed and manufactured, has poor fidelity. With this fact established, the operator then will not needlessly indict the front end and i. f. amplifier of the receiver if the same poor frequency response is noted in test 9. On the contrary, if test 9 had been made first, confusion would exist as to first point at which the poor fidelity appeared.

Required Instruments

The instruments required for taking complete receiver performance data may be found in any well-equipped service shop. They are (1) r. f. test oscillator or signal generator, (2) variable-frequency audio test oscillator, and (3) a. c. vacuum-tube voltmeter. In addition to these instruments, a dummy antenna (see Figure 1) must be constructed by the reader. Also, a power-type load resistor will be needed for connection in place of the loudspeaker voice coil. Following is a discussion of the required characteristics of the instruments.

R. F. Test Oscillator. This signal generator must be internally modulated 30% at 400 cycles and (for test 9) should have a jack or other provision for applying an external modulating signal from an audio test oscillator.

An important requirement is that the output attenuator must be calibrated to read the output signal strength in microvolts. Several manufactured service oscillators (such as the Jackson instruments, McMurdo Silver Model 906, and Clough-Brengle Microvolter) have direct-reading microvolt attenuators. Oscillators which are not calibrated in

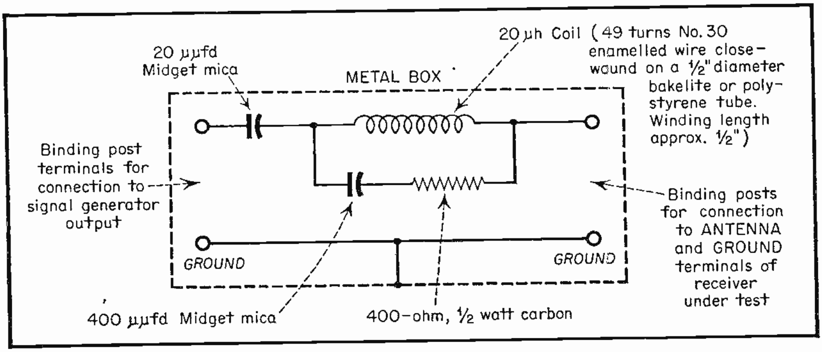

Fig. 1.

this manner may be checked against an oscillator which has such a calibration.

Audio Oscillator. This instrument must cover the frequency range 50 to 10,000 cycles and must have a continuously variable output attenuator. The maximum output voltage need not exceed 2 to 5 volts r. m. s. The output signal should be low in distortion. Resistance - capacitance - tuned oscillators are well-suited to this application, since their distortion percentage usually runs quite low.

Vacuum-Tube Voltmeter. An a. c.-type instrument is needed for both audio and r. f. measurements. The maximum full-scale deflection need not be more than 100 volts r. m. s. The v. t. voltmeter must have high input impedance to prevent excessive loading of the r. f. and i. f. circuits, and must have a capacitor-isolated input circuit to block any d. c. component encountered in the circuit under test. Suitable service-type voltmeters include the Sylvania Type 134 Polymeter, McMurdo Silver "Vomax," and RCA Voltohmyst with external diode probe. Instruments of similar design also are satisfactory.

Dummy Antenna. A circuit diagram of the standard dummy antenna is given in Figure 1. The parts may be mounted on a sheet of insulating material, such as bakelite or polystyrene, and enclosed in a small metal box or can. Coaxial jacks and plugs may be used instead of the binding post terminals, if the builder desires.

Load Resistor. In several of the tests, the loudspeaker voice coil must be replaced with a resistor having a resistance value equal to the impedance of the voice coil. The wattage rating of this resistor must be at least twice the normal watts output of the amplifier stage feeding the speaker. Thus, with an amplifier output of 2 watts, the resistor should be rated at 5 watts.

Test Conditions

When making tests 7, 8, and 9, the signal from the r. f. test oscillator must be fed into the front end of the receiver. That is into the antenna terminals. When the receiver has been

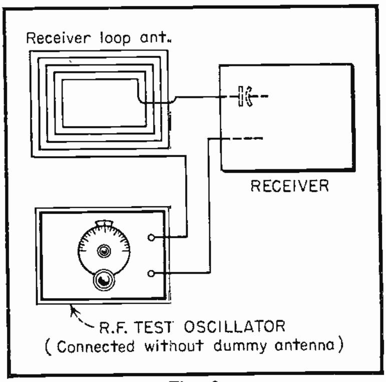

Fig. 2.

designed for connection to an external antenna, the dummy antenna (Figure 1) must be connected between the test oscillator and the input terminals of the receiver (see Figures 7 and 8). When the receiver is equipped with an

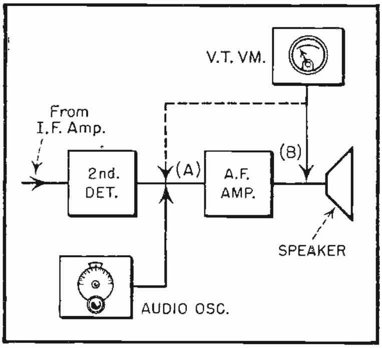

Fig. 3.

internal loop antenna only, one lead of the loop must be opened temporarily and the test oscillator output **(without the dummy antenna)** connected in series, as shown in Figure 2.

Unless instructed otherwise, all receiver tests must be made with a. v. c. and a. f. c. temporarily interrupted. The volume control(s) must be set for maximum volume. The tone control must be set to its center, or "mellow" position. The receiver must be detuned from any interfering signals picked up from the air.

Test Procedure

The block diagrams in Figures 3 to 8 inclusive show the connections of the test instruments to the various stages in a conventional a. m. superheterodyne receiver. These are the arrangements for making the ten tests listed earlier in this article under **Recommended Test Program.** The method of making the separate tests is explained below.

While we have shown a separate 1st detector and oscillator in the receiver, we are aware that many modern sets combine the two functions in a single converter stage. When working with a set containing a converter, treat the 1st detector in the diagrams as the detector section of the converter stage, and the separate oscillator in the diagrams as the oscillaror section of the converter.

1. **Audio Gain and Sensitivity.** Set up the audio oscillator and v. t. voltmeter as shown in Figure 3. Connect the v. t. voltmeter to point B; that is, across the speaker voice coil. Connect the oscillator to the input of the audio channel. If there is more than one stage in the audio channel, connect the oscillator to the input of the **first** a. f. stage. Set the oscillator to 1000 cycles, and advance the oscillator output attenuator until the loudest **undistorted** signal is obtained in the speaker. Record the meter reading at this point as E_1. Transfer the meter to point A at the input of the audio channel and record the voltage at this point as E_1. To determine the amplifier gain, divide E_1 by E_2: E_1/E_2. Repeat the test at several other frequencies.

To determine audio sensitivity, use the arrangement shown in Figure 4. Increase the oscillator output until the rated output wattage is developed across load resistor R. (Watts can be de-

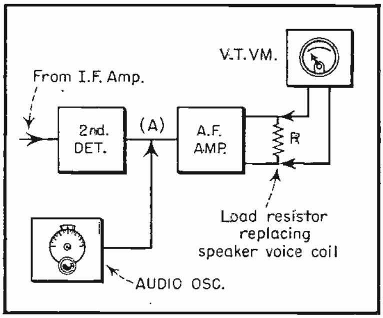

Fig. 4.

termined from the v. t. voltmeter reading by dividing the square of the voltage reading by the load resistance: E^2/R.) When rated power output is obtained, transfer the meter to point A at the input of the audio channel

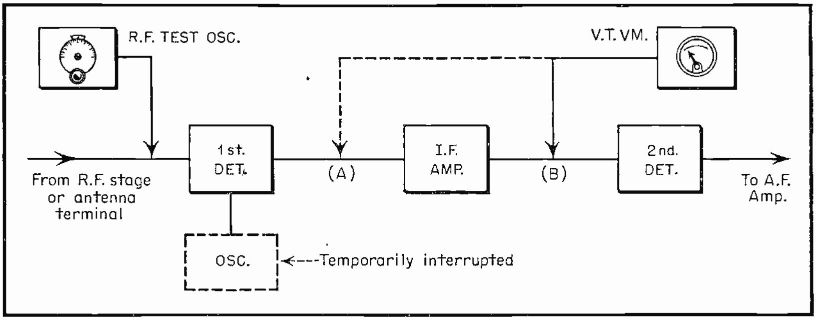

Fig. 5.

and read the input voltage. Power sensitivity is the ratio of the output power to the input voltage.

Repeat the test at several other frequencies, and at each setting of the tone control.

2. **Audio Power Output.** First, use the arrangement shown in Figure 3 to determine the value of input signal voltage which will give the loudest undistorted output signal. Then, without disturbing the oscillator or amplifier controls, replace the speaker with the load resistor (see Figure 4) and determine the audio output watts in the manner explained in the foregoing section **Audio Gain and Sensitivity.**

3. **Fidelity of Audio Channel.** Use the arrangement shown in Figure 4. Set the output of the audio oscillator to give rated amplifier power output at 1000 cycles. Note the voltmeter reading. Now, change the oscillator frequency in small steps from 1000 cycles down to 50, and from 1000 cycles up to 10,000, keeping the oscillator output voltage constant at all times (check the oscillator voltage by switching the meter temporarily to point A each time the frequency is changed). A high-fidelity amplifier will show very little output voltage change from the 1000-cycle voltage level as the frequency is varied from 100 to 10,000 cycles. Pronounced dips or peaks in the output voltage at various frequencies indicate poor frequency response which can be traced to defective or inferior components or to poor design.

Repeat the test at each setting of the tone control.

4. **I. F. Gain.** Use the arrangement shown in Figure 5. Connect the r. f. test oscillator to the 1st detector control grid. In some sets, it may be necessary to interrupt temporarily operation of the superhet oscillator. Connect the v. t. voltmeter to point B at the input of the 2nd detector. Set the oscillator to the intermediate frequency of the receiver, using either a modulated or unmodulated signal, and advance the output attenuator until a good, readable deflection of the meter is obtained. Record this reading as E_1. Read the microvolts output of the test oscillator from the calibrated attenuator and call this voltage E_2. Transfer the voltmeter to point A at the plate terminal of the 1st detector and increase the oscillator output further until the original voltmeter deflection (E_1) is obtained. Read the attenuator microvolts setting again and call this voltage E_3. The i. f. gain then may be determined by dividing E_3 by E_2: E_3/E_2.

Repeat the test for individual i. f. stages if there is suspicion that low gain is present in only one stage.

5. **I. F. Bandwidth.** Use the arrangement in Figure 5, with the v. t. voltmeter first at point B. Set the oscillator to the receiver intermediate frequency, using either a modulated or unmodulated signal. Advance the

oscillator output until a good, readable deflection (E) of the meter is obtained. Detune the oscillator below the intermediate frequency to the point where the meter deflection is barely readable on the lowest meter range. Read this

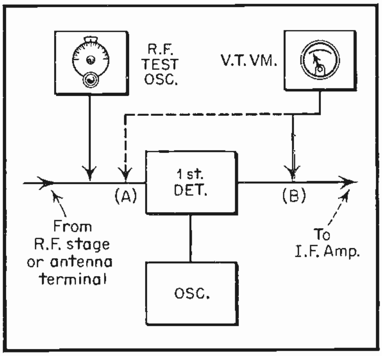

Fig. 6.

frequency (f_1) from the oscillator dial. Detune the oscillator above the intermediate frequency until the same reduced voltage point is reached, and read the corresponding frequency (f_2). A rough determination of i. f. bandwidth in kilocycles may be gained by subtracting f_1 from f_2: $f_1 - f_2$. A more exact overall picture is obtained, however, if the frequency is raised and lowered in small steps above and below the intermediate frequency, the corresponding voltages read, and the data used to plot a selectivity curve showing voltage vs. frequency, with the intermediate frequency at the center.

6. **Conversion Gain.** Use the arrangement shown in Figure 6. Set the oscillator to any clear frequency within the tuning range of the receiver and use either a modulated or unmodulated signal. Connect the v. t. voltmeter first to point B at the 1st i. f. control grid. Tune the receiver for maximum deflection of the meter and advance the test oscillator output to give a meter deflection of 0.05 to 0.1 volt r. m. s. At this point, record the microvolts setting of the attenuator as E_1. Transfer the voltmeter to point A at the control grid of the 1st detector and read the voltage at this point as E_2. Determine the conversion gain by dividing E_1 by E_2: E_1/E_2.

Repeat the test at several frequencies within the tuning range of the receiver.

7. **Selectivity.** Use the arrangement shown in Figure 7. Tune the receiver to a **modulated** signal from the test oscillator, and advance the oscillator output until full rated output watts are read across load resistor R (see Test 2). Detune the oscillator below the receiver dial setting until a point is reached at which the voltmeter deflection falls to zero. Read the fre-

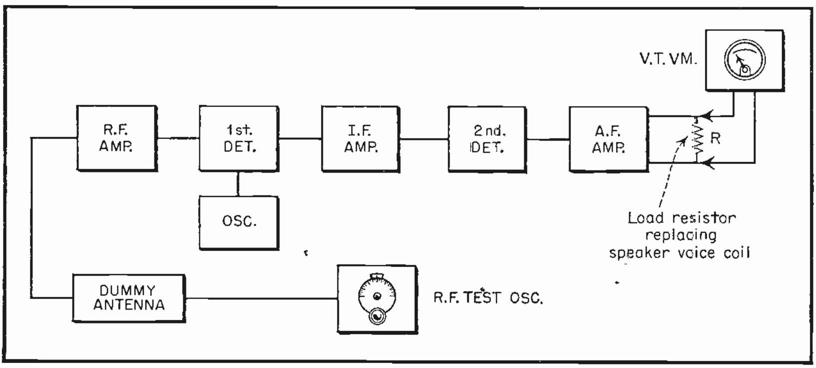

Fig. 7.

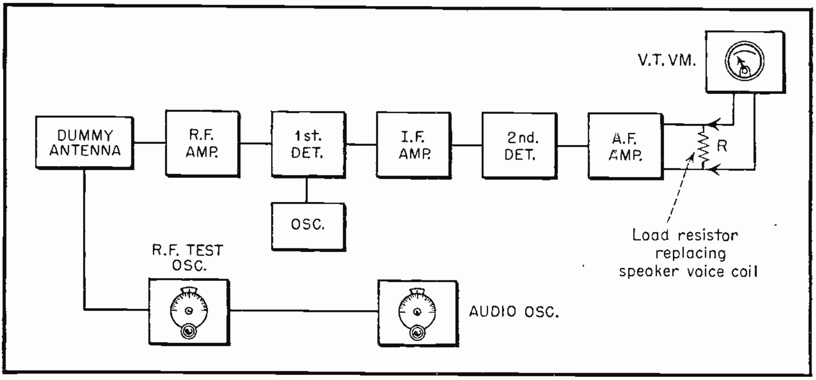

Fig. 8.

quency (f_1) at this point from the oscillator dial. Similarly, detune the oscillator above the receiver dial setting until the voltage again falls to zero, and read the corresponding frequency (f_2) from the oscillator dial. Points f_1 and f_2 are the closest frequencies which will not cause interference at the frequency to which the receiver dial is set. They accordingly indicate the front-end bandwidth. Thus, $f_2 - f_1$ gives an indication in kilocycles of the receiver selectivity. To obtain a more complete picture of selectivity, detune the oscillator above and below the receiver setting in equal small steps, record the corresponding output voltages, and plot a selectivity curve showing voltage vs. frequency.

Repeat the test at several frequencies within the tuning range of the receiver.

8. **Sensitivity.** Use the same arrangement, with a modulated signal, shown in Figure 7. Set the test oscillator signal to give full rated output watts, as read with the v. t. voltmeter (see Test 2), and at this point read the sensitivity directly in microvolts from the attenuator of the test oscillator.

Repeat the test at several frequencies within the tuning range of the receiver.

9. **Overall Fidelity.** Use the arrangement shown in Figure 8. Set the audio oscillator to 1000 cycles. Tune in the modulated signal with the receiver, and set the attenuator of the r. f. oscillator for full rated output watts as read with the v. t. voltmeter (see Test 2). Vary the audio oscillator frequency (keeping the audio output voltage constant at all times) and note any rise or fall in the v. t. voltmeter deflection. A high-fidelity receiver will show only small changes in output voltage as the modulating frequency is varied between 100 and 5000 cycles.

Repeat the test at several r. f. test oscillator frequencies within the receiver tuning range, and at each setting of the tone control.

10. **Noise or Hum Level.** Use the arrangement shown in Figure 3, except **do not use the audio oscillator in this test.** Connect the v. t. voltmeter to point B; that is, across the speaker voice coil. Short-circuit the antenna and ground terminals of the receiver to prevent pickup of signals or static. Note the voltmeter deflection which is due entirely to hum or noise. This signal voltage may be identified (that is, whether it is noise or hum or both) easily by listening to the speaker output. Repeat at each setting of the tone control. A significant figure is the ratio of this hum or noise voltage to the voltmeter deflection at full signal output.