Locating Hum in A.C. Sets

Stage by Stage Analysis

By W. T. COCKING
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Accompanying is an article of great interest to constructors and, indeed, to all users of A.C. sets. We all know how extremely difficult it is to locate definitely annoying hum, and this article, by a well known English radio engineer, should prove of considerable value.

EVERY reader who has experimented with mains receivers must at some time or other have experienced the annoyance of hum. The locating of the source of difficult part of the problem, trouble is by far the most but once it is found its cure is usually fairly easy. In order to illustrate the principles involved, the commonly used circuit of Fig. 1 will be taken as a basis for discussion, and the modifications necessary for other circuits will become apparent. It will be assumed that the complete apparatus is built into one unit, and that it performs satisfactorily with the exception that there is excessive hum.

It will be realised that a systematic investigation of the set is essential, for the hum may be introduced in many places at once, and the elimination of one source alone often makes little audible difference. The obvious starting point is the loudspeaker; it is very unlikely, although not impossible, for there to be hum in a reed-drive-type speaker, but it is a very probable source of trouble if it be of the mains-energised moving-coil type.

The procedure to be adopted, therefore, is to connect the moving-coil to the loudspeaker terminals on the set in the usual manner, and to switch off the set, leaving only the field energised. Any hum must now be due to the field supply, and must be eliminated in one of the many well-known ways. If the field be of the low-voltage type supplied by a metal rectifier, the trouble can usually be cured by connecting in parallel with the winding an electrolytic condenser of high capacity. With a high-voltage field winding supplied by a valve rectifier, or D.C. mains, it will usually be necessary to add a smoothing choke in series with the winding, in addition to a 2 mfd. or 4 mfd. condenser in parallel with it.

The Output Stage.

Having made certain that the loudspeaker introduces no hum one can tackle the set in earnest. The first step is to make sure that there is no electro-magnetic interaction between the output choke, or transformer, and the mains transformer. To do this disconnect the choke from the valve and H.T. supply, and connect across it a resistance equal in value to the anode A.C. resistance of the power valve, as shown in Fig. 2a for choke and Fig. 2b for transformer coupling. Under these conditions there should be no audible hum whatever, and if this be the case, the connections may be put back to normal. If hum be found, however, the choke or transformer must be rotated, or moved to a different position in the set, until a position is found which gives silent operation. Trouble in this portion of the receiver is rather unlikely, for no amplification follows the output circuit, and any pick-up is not likely to be at all serious.

The next step is to isolate the output stage, and to do this we short-circuit the secondary of the intervalve transformer by connecting a length of wire between the points, a, b, Fig. 1. We have proved the loudspeaker and output circuit to be free from hum, and any hum with the inter-valve transformer secondary short-circuited must obviously be due to the H.T. supply, the grid bias supply, or the filament of the power valve.

The latter is the most easily tested by heating it temporarily from an accumulator, when the possibility of the trouble in the filament supply ceases. An accumulator is not always available, however, and in this case the return lead c to the centre tap on the mains transformer should be disconnected and connected instead to the slider of an adjustable potentiometer, which in turn is connected across the valve filament yy, as shown in Fig. 3. If a position can be found on the potentiometer at which the hum is absent, then it is due to the filament supply; the mains transformer tapping is out of balance, and the potentiometer should be retained permanently.

If no better results are obtained by the use of a potentiometer, however, the trouble must lie in the H.T. or grid bias supply; unless the valve used is one with a thin filament and itself introduces hum, or there is an excessive capacity between the different windings on the mains transformer. The H.T. supply is most easily tested by increasing the capacity, say, by 4 mfd., of the condenser C1; if this results in an improvement it is the smoothing circuit which is at fault. The choke inductance must be increased or the capacity of the condenser C1, or both, in accordance with well-known principles; a further possibility, however, lies in electro-magnetic induction between the smoothing choke and the mains transformer, and the effect of rotating the former should be tried. The grid bias supply may be tested by connecting an additional 4 mfd. capacity across the condenser C2, or across the bias resistance R1. If any improvement results, a condenser of the correct capacity should be connected permanently in these places, or in extreme cases an additional choke can be used.

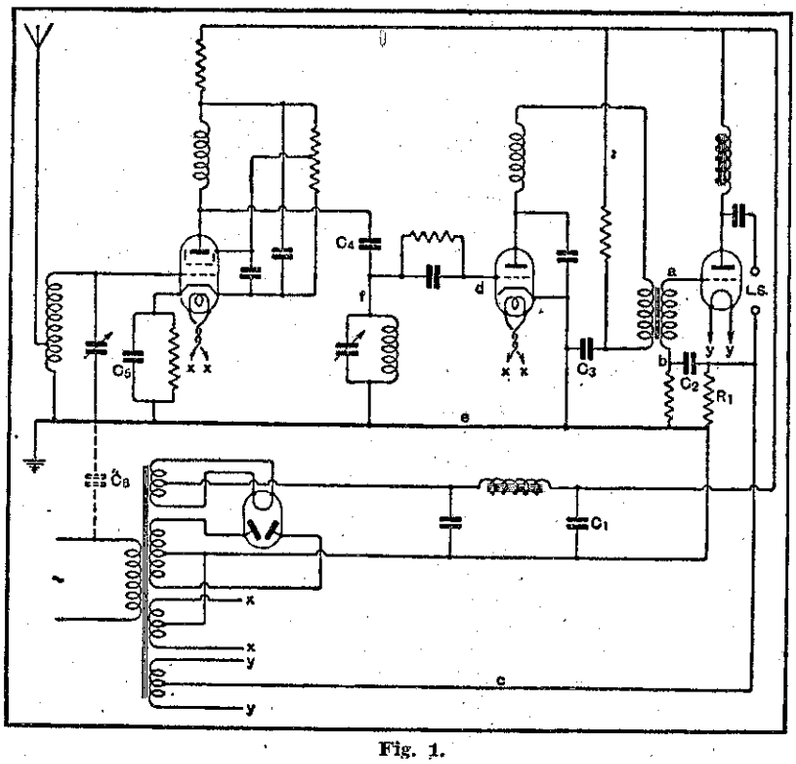

Fig. 1.

The Detector.

We next come to the detector and its intervalve coupling, and the short circuit to the L.F. transformer secondary should be removed. Now this transformer is, perhaps, the most likely source of hum in a compact set, and very careful attention should be given to its position. The test is the same as that for an output transformer; the primary must be disconnected; and then connected to a resistance whose value is equal to the normal working resistance. That is to say, in the case of the circuit of Fig. 1, a resistance equal to the internal valve resistance, some 10,000 ohms for an AC/HL-type valve; but where a resistance-fed transformer is used, the resistance should be equal to the valve resistance and the coupling resistance in parallel, some 6000-7000 ohms for an AC/HL and the circuit of Fig. 4.

The necessity for this primary shunt resistance during testing is to stimulate the working conditions as far as hum pick-up is concerned; it will be found that without this resistance there is a very large amount of hum, which is not normally audible, while if the transformer primary be short-circuited, all hum vanishes. Having connected the correct value of resistance across the transformer primary, it should be rotated to the position of minimum hum; and in order to do this it is, of course, necessary to replace the normal connections to it by sufficiently long flex leads. It may be mentioned that simple rotation will not always cure hum, and the transformer must sometimes be turned on its side, or in some other curious position.

When a suitable position has been found for the transformer, its primary should be reconnected, and the grid of the detector valve short-circuited to the cathode by connecting a length of wire between the points d, e, in Fig. 1. Any hum is now due to the H.T. supply to the detector, and more smoothing is indicated. The effect of adding capacity to the condenser C3 should be tried, and if there be an improvement, a large capacity should be connected permanently in that position. In a few cases, of course, an excessively large capacity may be needed, and it is then more economical to add an additional choke and condenser at the point z in the H.T. supply.

The next step is to check the detector grid circuit, which can be done by removing the short-circuit between the points, d, e, and applying it to the other side of the grid condenser; that is, to the points e, f. At the same time, the connection between the condenser C4 and the tuned circuit should be broken. The detector grid is now connected directly to the cathode through the grid leak and condenser, and any hum will usually be due to electro-static pick-up on the grid. This will occur if the heater wiring is placed close to the grid of the valve, but more usually it is due to pick-up from a higher voltage source. The positions of the wiring in the H.T. rectifier and smoothing systems should be examined, but the most likely source of trouble is the mains transformer. Fortunately, screening is often of great use in eliminating electro-static pick-