The majority of remaining hum is usually due to electro-static coupling, particularly with fairly-low-level stages on the same chassis as the power supply. The cure is to place an electrostatic screen either around the points of high ac potential or around the low level stages. Points which could be watched in this regard are the mains socket, mains switch and fuse. The electrostatic screen may consist of a strip of steel or aluminium with a width of about ¼" less than the height of the chassis. It may be mounted with a small gap between the chassis and the strip to allow the wiring to pass underneath. Rearrangement of some of the components may be necessary to make a tidy job of the screen. A good place for the screen in a conventional push-pull amplifier is immediately preceding the phase-splitter.

Measurement of the hum should be made both with and without the screen. If the improvement is worthwhile, either the screen may be retained or the components and wiring may be modified to reduce the hum due to this cause.

Back in 1952 the U.S. National Bureau of Standards carried out a limited investigation of heater hum. This showed that by a suitable choice of valves and circuitry heater-induced hum (50 cps) in ac-operated low-level amplifiers can be reduced to less than 4 microvolts, whereas carelessness in selection and construction of the amplifier and its components may result in heater-hum levels of over 500 microvolts.

Hum is not significantly affected by normal variations of components such as plate and screen resistors, by-pass capacitors, and so on. In general it was found that the lowest hum figures were obtained in amplifiers using either a triode or pentode with by-passed cathode, heater grounded through an adjustable potentiometer ("hum-dinger" arrangement), and with low grid-circuit impedance.

Without the cathode by-pass capacitor, hum was of course much greater; a sufficiently large by-pass capacitor is obviously desirable for all low-hum applications. Return of the heater circuit through an adjustable potentiometer connected across the heater supply, when adjustment was optimum, reduced the hum to as little as 1/20 or even 1/50 of the initial value. Returning the heater circuit through 45 volts, either positive, or negative but preferably positive, reduced hum somewhat in most cases. Increased grid circuit resistance tended to give greater hum in triodes, while in pentodes hum in general either showed no change or else decreased with increased resistance.

SECOND HARMONIC DISTORTION

Calculating Distortion

A formula is available* for the calculation of second harmonic distortion from a knowledge of the relative lengths of the upper and lower portions of the load-line. In the diagram, the operating point is at Q and the loadline is EQC. If there is no second harmonic distortion, EQ will be equal in length to QC, but in all practical cases with triodes, and in the majority of cases with pentodes, there will be a certain amount of second harmonic. The formula given in the Radiotron Designer's Handbook is

$$\text{\% second harmonic } H_2 = \frac{EQ - QC}{2\,(EQ + QC)} \times 100$$

This may be put into a form more convenient for operation on a slide rule, using the ratio EQ/QC as a basis —

$$H_2 = \frac{\dfrac{EQ}{QC} - 1}{2\,\dfrac{EQ}{QC} + 1} \times 100$$

An example will show how simple this becomes with a slide rule:—

* "Radiotron Designer's Handbook," 4th Edition, p282.