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NOTE ON A CAUSE OF RESIDUAL HUM IN RECTIFIER-FILTER SYSTEMS*

By

Frederick Emmons Terman and Sidney B. Pickles
(Stanford University, California)

Summary—*The capacitance of the power transformer secondary to ground is shown to by-pass the filter system when the filter chokes are in the negative lead and the negative output is grounded. This results in a residual ripple voltage across the output that may be greater than the ripple voltage passed by a very good filter. The remedy is either to place the filter inductance in the positive lead or to ground the positive output terminal.*

WHILE making measurements on a rectifier-filter system arranged as shown in Fig. 1 with constants such as to produce excellent filtering, it was found that the hum voltage developed across the output was several times that which calculations would lead one to expect, and increasing the amount of filtering had no appreciable

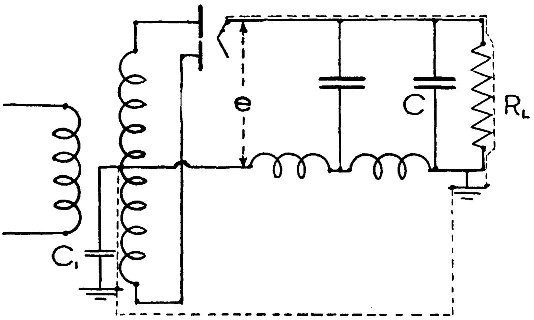

Fig. 1

effect upon this hum. In endeavoring to locate the cause of this behavior it was found that either grounding the positive lead, or placing the filter inductances in the positive line as shown in Fig. 2, brought the hum down to the predicted value.

Consideration of these factors lead to the conclusion that the residual hum must be the result of the capacitance between the secondary winding and ground. This capacitance obviously by-passes the entire filter system of Fig. 1 and causes a small ripple current to flow as shown by the dotted lines in Fig. 1. This produces a voltage across the load

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impedance, and also a voltage between the negative line and ground if the negative line is grounded through an impedance.

If e is the ripple voltage delivered by the rectifier output then the residual hum current flowing along the dotted path in Fig. 1 is very nearly

$$\text{hum current} = j\omega C_1 e. \tag{1}$$

This is because C_1 offers nearly all of the impedance present in the dotted path. Since the final filter condenser C always has a low re-

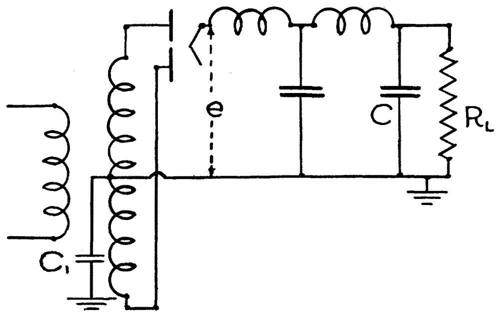

Fig. 2

actance compared with the load, the hum voltage developed across the load is approximately

$$\text{hum voltage across load} = e\frac{C_1}{C}\cdot \tag{2}$$

In the case observed the capacitance C_1 as measured was 600 micromicrofarads. The 120-cycle component of the ripple delivered by the rectifier was 240 volts. Substitution of (1) shows that the expected residual 120-cycle ripple current would be 108 microamperes, which is to be compared with an actually measured value of 113 microamperes. With an 8-microfarad output condenser this current develops approximately 0.018 volt hum across the load, which is enough to cause trouble in many circumstances.

These considerations make it apparent that for low hum the filter reactors should be in the positive lead. In the case that other considerations make it necessary to place some chokes in the negative lead, then the last section of filtering must have its impedance in the positive line.