Silicon v. Nickel for Audio Transformer Cores

Improvements in Design.

AN interesting article bearing upon the improvement of audio transformers appears in the latest issue of the General Radio Experimenter, as follows:—

DEVELOPMENTS in loudspeakers made in recent months have resulted in instruments which have extended the reproducible range of frequency by some seventy-five to one hundred cycles downward. At the same time there has been a downward extension of the frequency range transmitted by broadcast stations. These factors have combined to revise the requirements for satisfactory performance of audio transformers. A year ago, there was little justification for audio transformers reproducing frequencies much below one hundred cycles, since none of the speakers then available were capable of producing an audible sound at such frequencies, even though it was present in the broadcast transmission, which it was not.

AS a result of these developments, the low frequency cut-off of audio transformers has been moved steadily until transformers are demanded which will amplify sixty, or even thirty cycles.

Why High Frequencies are Lost.

The design of such transformers has not involved any new principles, but rather the overcoming of practical difficulties involved in the adaptation of well-known principles. The problem of raising of the lower end transformer characteristic is primarily one of increasing the input inductance of the transformer, although the lowering of the plate impedance of tubes has had the effect of improving the characteristics of transformers of earlier designs. The inductance of the transformer depends upon three factors, the number of turns of wire on the coil, the size of the core, and the permeability of the core material. The gain in inductance which may be had by adding primary turns is limited by the fact that the secondary turns must also be increased unless the turns ratio is lowered. The result is the loss of high frequencies as a result of coil capacity.

Nickel Cores.

THE high permeability nickel alloys are being used to an increasing extent for audio transformers. These alloys of nickel and iron have the property of high permeability at low flux densities, the conditions encountered in audio transformer primaries.

These alloys have, however, some disadvantages. The high permeability is maintained over a rather limited range of flux density, and falls off rapidly at higher or lower values.

Advantages of Silicon.

SIMPLY stated, such cores saturate easily. This difficulty is becoming more important as the plate currents of vacuum tubes are increased. A more serious objection yet is that the transformer is permanently damaged by an increase in field strength such as might result from accidental connection in a circuit without a "C" battery, or where a "C" battery was run down, or where the plate current was abnormally large for any other reason. Such temporary increase in flux through the core permanently changes the characteristics of the material. Silicon steel, on the other hand, is not permanently affected by increases in flux. The frequency characteristics of the transformer is of course affected by core saturation while it exists, but the effect is not lasting. These considerations render the nickel alloy transformers particularly valuable for special laboratory work, or in commercial installations where care is taken to ensure proper operating conditions. The ruggedness of the silicon core type of transformer, however, recommend it for general experimental use where conditions are frequently hard upon delicate apparatus. All the electrical advantages of the nickel alloys may be obtained with silicon steel by adjustment of other factors in the design.

Importance of Coil Design.

IT was found that when the lower end of the characteristic had been extended as desired, by changes in the coil and core, there was a tendency to resonance at high frequencies as well as a falling off of amplification. These difficulties were overcome by changes in coil design. The resonance effects at high frequency are due to leakage reactance, i.e., flux not linking both primary and secondary coils, and by coil capacity. The loss of amplification at high frequencies is due to internal coil capacity, principally in the secondary. It was found possible to reduce both these effects by a form of coil construction which sandwiches the primary between two sections of the secondary. This type of winding not only reduces leakage reactance by increasing the coupling between primary and secondary, but also reduces the internal capacity of the secondary by breaking it up into two sections.

In the Type 585 General Radio transformers silicon steel has been used as a core material. The coils are of the sandwich type described above. The result of this construction is a transformer possessing a practically flat frequency characteristic from 30 to 6000 cycles.

QUERIES BY CORRESPONDENCE.

1. Every communication enclosing queries is to be addressed to "Megohm," Box 1032, Wellington, and must be accompanied by a stamped addressed envelope for reply by post, otherwise no reply.

2. Questions must be written so that a space is left in which the reply may be added.

3. Queries regarding articles that have appeared in this page will have first attention.

4. Owners of bought receivers and apparatus should communicate with the dealer or agent in case of trouble arising.

Tips and Jottings

Use Good Resisters.

TOO much care cannot be taken in the choice of resistances for use in any part of a receiver, for there is no more prolific source of artificial "static" than faulty resistances.

R.F. Instability.

THE failure to stabilise an R.F. circuit may be due to a number of causes, the most common being short-circuited turns in either the primary or neutralising windings on the R.F. transformer, high-resistance contact between the transformer pins and sockets on the base, or faulty neutralising condenser. Should high-frequency oscillations find their way into the audio portion of the receiver, this trouble will arise, but incorporating an R.F. choke in the plate circuit of the detector valve should preclude this possibility. The components concerned should be carefully examined for any of the faults mentioned above, special attention being given to the neutralising condenser. Certain types have a rather high minimum capacity, but in most cases this can be reduced by stripping off a few of the plates.

High-resistance contact between pins and sockets can usually be traced to either dirty pins or sockets; alternatively, if the split type of pin is used, this may require "splaying out" before a good contact will result. A careful examination of the R.F. transformer will enable any short-circuited turns to be located.

Grid Leak to Filament.

IN some circuits it will be noticed that the grid leak is placed between grid and filament instead of across the grid condenser. It will be found in most cases that very little difference is noticeable whether the grid leak is connected directly across the grid condenser or from the grid to the filament. In certain receivers, however, it has been found that slightly better results are obtained by using the grid-to-filament connection. In this case the end of the grid leak farther from the grid of the tube should go to A positive in order to give the grid the positive bias necessary for grid-leak detection with special tubes.

If the detector is the first tube of the set and the grid return is connected to the positive side of the filament circuit, the leak may be used directly across the grid condenser, since the grid will obtain its positive bias through the tuning coil. The same applies when the detector tube follows a stage of radio-frequency amplification, if the grid return of the R.F. transformer goes to A positive. Since this is the usual connection of the grid return in most receivers, the placing of the grid leak across the grid condenser will probably prove most satisfactory.