Ferrite Applications In Electronic Components

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Ferrite Applications

Small-size high-voltage tv transformer cores and ferrite rod antennas for portable receivers are two outstanding uses of ferromagnetic spinels. Wide application is promising because of high maximum permeability, high electric resistivity and low r-f losses

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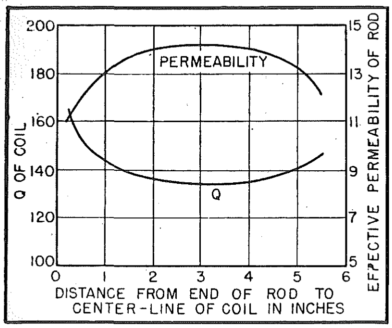

FIG. 1—Variation in Q of coil and permeability of ferrite rod with position of coil on rod

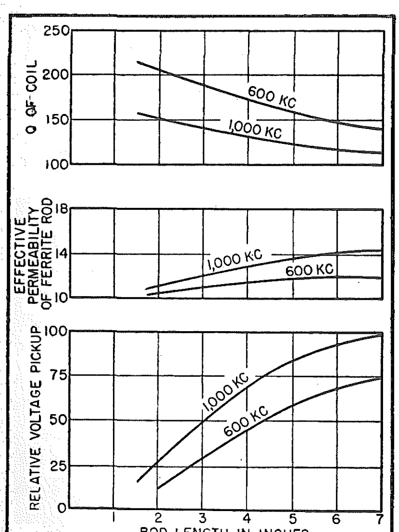

FIG. 2—Variation of Q of coil, permeability of ferrite rod and voltage pickup of antenna with rod length

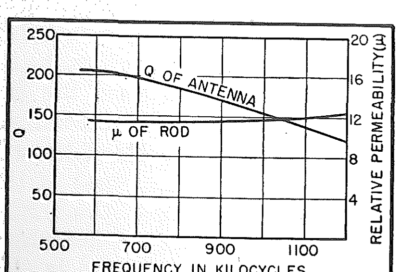

FIG. 3—Variation of Q of antenna and permeability of rod with frequency

RECENT YEARS have seen an increasing use of ferromagnetic spinels, commonly called ferrites, in electronic components to replace silicon-steel laminations, iron wire and powdered iron and to provide components having improved characteristics and reduced bulk.

Characteristics of ferrites such as high maximum permeability, high electric resistivity and low r-f losses, are of particular interest for television components such as yokes and horizontal-deflection output and high-voltage transformers. In such components, the use of ferrites has made an important contribution to increasing operating efficiency and reducing size.

Deflection Transformers

The high power required for deflection in wide-angle kinescopes necessitates the use of efficient deflection systems.

The single item used in the design of a horizontal-deflection output transformer that almost completely determines its efficiency is the magnetic material used for the core. Ferrites have been developed exhibiting characteristics that are very favorable as core material for such transformers. As a result, transformers operating from a moderate power supply with only a single high-voltage rectifier and capable of deflecting kinescopes having a 66-deg horizontal-deflection angle at anode voltages up to 18 kv, have been designed with small C-shaped ferrite cores. The total weight of the ferrite core for such a transformer is approximately 75 grams.

Compact ferrite cores also permit the use of compact coils having high coupling coefficients between primary and secondary windings which reduce the likelihood of Barkhausen oscillations and provide efficient performance.

Ferrites have also made an important contribution in the design and development of deflecting yokes for scanning wide-angle picture tubes. For the flux-return path in these yokes, the ferrites provide a high-permeability low-loss magnetic material which is considerably superior to early powdered-iron cores, and iron core wires.

Ferrite Rod Antenna

Another application in which the use of ferrites has resulted in improved physical and electrical characteristics is in the antenna of small personal radio receivers. Personal receivers in the past have used a flat air-core loop antenna nested within a hinged lid. For satisfactory operation it is necessary to suspend the loop in free space away from the chassis and components so that the loop Q and re-

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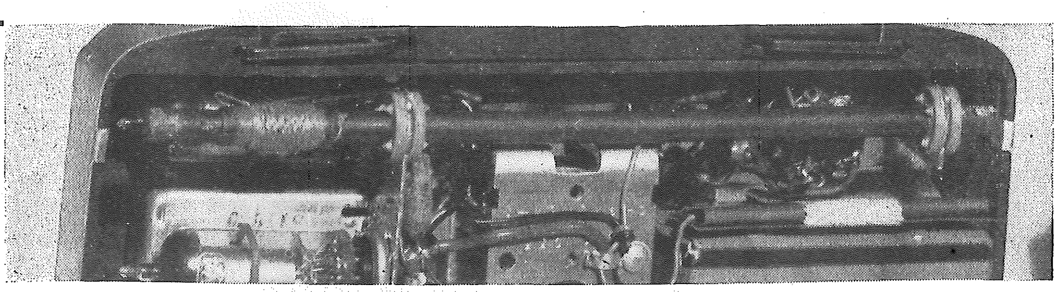

An RCA personal portable receiver showing relative size and location of antenna near top

ceiver performance would not be greatly reduced. The inherent mechanical and breakage troubles have made this type mounting very undesirable.

The new ferrite rod antenna is shock-mounted to the receiver chassis and insulated from it by two soft rubber grommets. The supports holding the grommets have slotted holes to eliminate the shorted-turn effect of metal surrounding the rod.

This complete antenna occupies less than two square inches in area and in a confined space, as compared with the conventional loop antenna of greater than 20 square inches in free space.

For optimum performance, the small coil and the ¼ by 7-in. rod should have the highest possible Q when in its mounted position. The rod must possess low-loss characteristics and high permeability. The pickup ability of the antenna and the signal-to-noise ratio of the receiver are dependent on these two basic criteria, on the resultant tuned-circuit impedance and on certain other design considerations such as the type of wire, winding and form factor of the coil on the ferrite rod.

For a given ferrite rod, there is a particular combination of size, shape and winding pitch factor that, along with the correct ratio of coil diameter to rod diameter, results in maximum pick-up voltage. These factors determine the degree of coupling to the rod and, therefore, the amount of signal flux leakage and self-inductance leakage. Eddy-current losses between adjacent turns and also the distributed capacitance of the winding are reduced by the use of the progressive universal-type winding with 15/43 E.S.S. wire.

Coil Position

The positioning of the coil on the rod is also important. Losses due to ferrous metals close to the rod reduce the Q of the complete assembly; the loss is greatest when the metals are close to the coil winding. Nonferrous metals induce less loss into the antenna but offer some shielding to magnetic pickup. In the RCA receiver, the chassis is constructed of brass, the ganged tuning capacitor has an aluminum frame and the antenna coil is located as far from surrounding components as is compatible with the need for compactness.

The coil is positioned close to one end of the rod for several reasons. First, maximum Q is obtained when the coil is in this position. Second, the effective permeability decreases as the coil approaches the end. This feature is useful in manufacture because it permits adjustment of the antenna to the correct inductance without the necessity for adjusting turns. Fig. 1 shows these effects. The average position is for the center line of the coil to be one inch from the rod end. Adjustment of the coil over the range of ± one-quarter inch represents a change in inductance of about 10 percent.

Another feature due to the smallness of the ferrite antenna is its low distributed capacitance of only two μμf as compared with 14 μμf for conventional loops. With this lower capacitance, it is possible to obtain a higher tuned-circuit impedance because a smaller capacitance range is needed in the ganged-tuning capacitor and a greater value of coil inductance may be used.

The sensitivity of the antenna increases with the number of turns making up the antenna inductance. With the ferrite antenna, the reduced capacitance requirements make possible the use of a compact tuning capacitor having increased plate spacing. The increased spacing reduces capacitor rejects in the factory and minimizes any microphonic tendencies at the higher audio levels.

Ferrite-Rod Dimensions

The length of the ferrite rod has an effect on both the Q of the antenna and the effective permeability. Figure 2 shows variation in Q with incremental increases in the length of the ferrite rod. This variation is due to the greater inherent losses in the longer rods coupled into the antenna coil. Also shown in Fig. 2 are the variations in effective permeability and the relative voltage pickup with rod length. The voltage pickup varies almost directly with rod length and approximately as the square of the rod diameter.

Figure 3 shows the variations with frequency of Q and effective permeability of an antenna having the antenna coil located with its center line one inch from the rod end, the normal operating position. The signal-to-noise ratio of the antenna is improved over that of the conventional loop due to the higher operating Q and the smaller physical size. The smaller size is significant because it reduces the electrostatic pickup.