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EXPERIMENTAL STUDIES ON FERRITE LOADED RECTANGULAR LOOP ANTENNA

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1. INTRODUCTION

In MF or HF region, the ferrite loaded antennas are beneficial for volumetric constraint where the unloaded antenna has very low efficiency [1]. In UHF range, however, the ferrite core antennas have been considered unprofitable because the magnetic loss of ferrite core increases with frequency. Nevertheless, recent advances in ferrite technology have broaden the frequency range of its applications.

In this paper, by means of assembling the ferrite core to a single turn rectangular loop, an experimental approach to obtain the low profile or small antenna in UHF region is proposed. It is shown that the ferrite loaded loop antenna has a few DB of gain relative to equivalent air core antenna even in UHF region.

2. EXPERIMENTS

Fig.1 shows the experimental set up of the ferrite loaded rectangular loop antenna, which is built on the image plane. A thin ferrite core of square shape with 6 cm on a side and 7 mm in thickness is inserted in air space of the square half loop conductor of the same size but 3mm diameter.

The ferrite core used in the loop is a sintered ferrite (IB-003) made of Ni-Zn, which is developed by T.D.K. as the electromagnetic wave absorbing material in UHF region. Frequency characteristics of its permeability $\mu_r = \mu_r' - j\mu_r''$ is shown in Fig.2 [3].

Input impedances of the ferrite loaded rectangular loop and unloaded loop are shown in Fig.3. It is known from our study that the resonant wavelength of rectangular loop antenna is longer that that in free space by about 10~20% [4]. This is shown in Fig.3, where the resonant frequency of unloaded loop is about 950MHz. On the other hand, the resonance of the ferrite loaded loop occures at about 730MHz, which is about 80% to that of unloaded loop. This means that the equivalent permeability of this ferrite core is estimated almost $\mu_r' = 1.6$ at 730MHz. Although this value of the permeability seems to be smaller than that being expected from data in Fig.2, the present results show that the ferrite loading is beneficial for improving input impedance characteristics of the loop antenna with reduced size.

Directive gain of the ferrite loaded loop and unloaded loop are measured. Fig.4 shows the frequency characteristics of the relative gain of ferrite loaded loop over the unloaded loop.

It is very interesting that a certain relative gain is observed within some frequency range where unloaded loop has considerably low gain. This result is explained as follow; since the wavelength of ferrite loaded loop is shorter than that of free space, the length of the loop conductor seems to be expanded to a certain length enough to yield the high radiation resistance which may overcome the loss resistance due to magnetic loss.

The measured radiation pattern of the ferrite loaded loop antenna of configulation given Fig.1 is plotted in Fig.5 for vertically polarized field.

3. CONCLUSION

The ferrite loaded loop antenna is investigated in UHF region, utilizing a sintered ferrite core made of Ni-Zn as loading element. Fairly good perfomances of input impedance and a certain gain over unloaded loop of the same size are obtained. It is expected for the purpose of designing a low profile or small antenna that the proposed ferrite loading technique is beneficial even in UHF region.

It is noted that the ferrite core used in present experiments is developed for the purpose of electromagnetic wave absorber. If more efficient magnetic material such as ferroxplane suitable for UHF region is selected, more attractive perfomances may be expected.

The radiation efficiency of the proposed antenna has not been investgated.

REFERENCES

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3. Y.Naito and E.Fujiwara;"The thickness of electromagnetic wave absorber utilizing ferrite", J. Inst. Electron. Commun. Eng. Jap., vol.53-B, No.9, pp.537-545 (Sept.1970)
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*3,4 are in Japanese

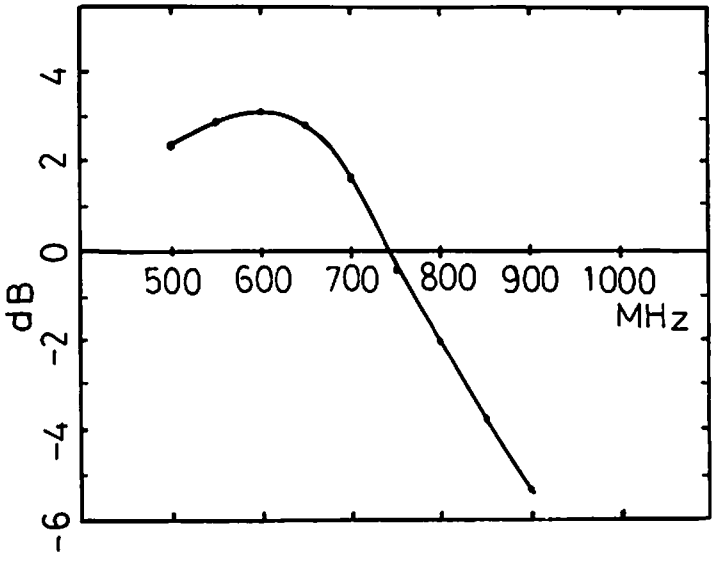

Fig.4 Relative gain of the ferrite loaded rectangular loop antenna to air core antenna of the same size.

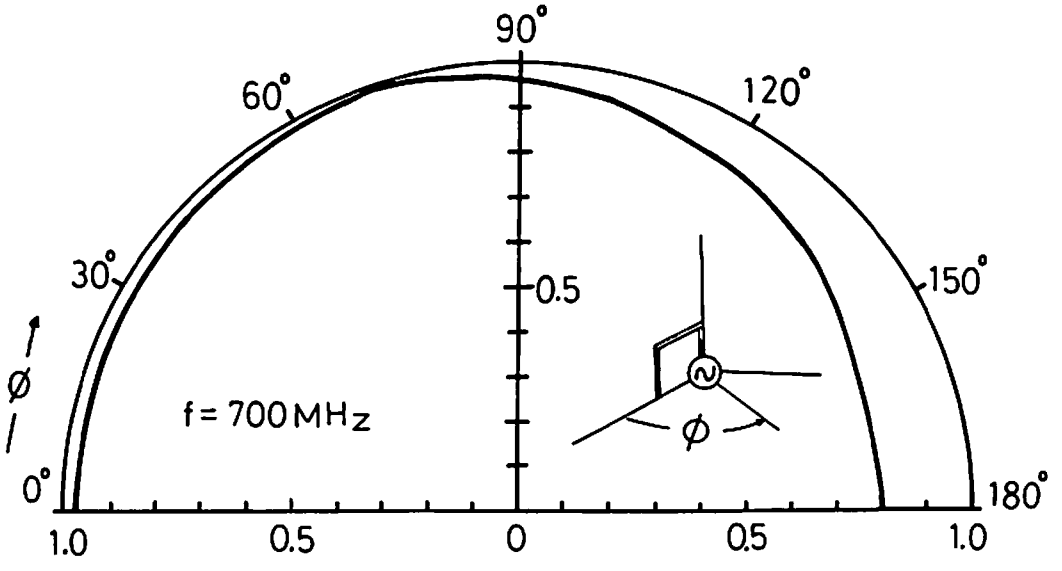

Fig.5 radiation pattern of the ferrite loaded loop antenna.

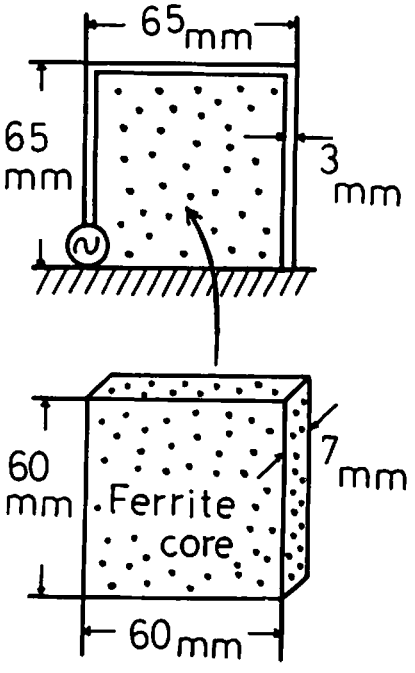

Fig.1
Ferrite loaded rectangular loop antenna.

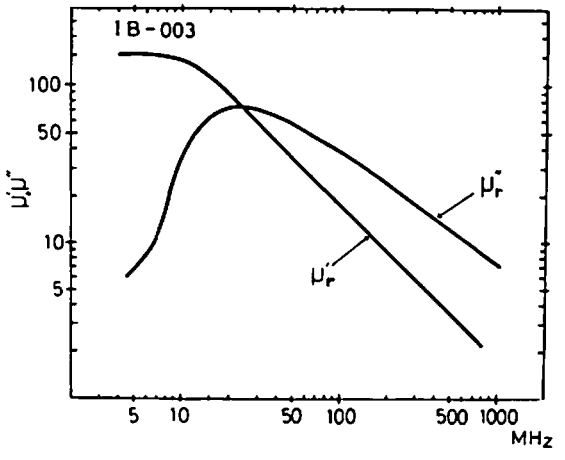

Fig.2 Relative permeability of the ferrite core

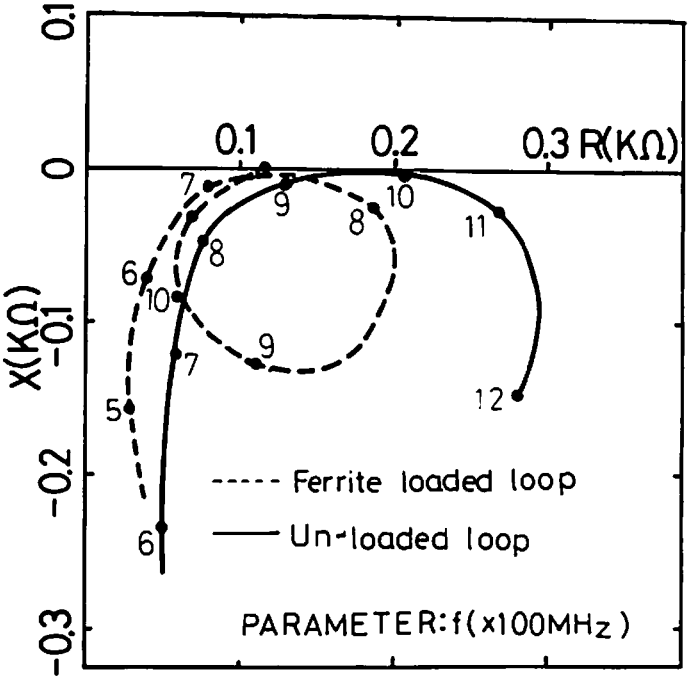

Fig.3
Input impedances of the ferrite loaded rectangular loop and unloaded loop.