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Zeroing Instead of Grounding

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Abstract: This paper proposes explanation of existing methods of zeroing on basis of earth using. It is showed different constructions of several types of zeroing systems (nullifiers) for different implementations. Methods for obtaining a zero-input impedance of a nullifier and reducing its current to almost zero without using earth are described.

Key words: Lightning, lightning rod, current drain, counterweight, linear antenna, single-wire system.

1. Introduction

Practically in all electrical systems or devices it is necessary to make zeroing. It is needed for safety of service, for enabling signal transmission over an unbalanced line, for using unbalanced antennas such as a monopole and in other cases.

Usually, grounding is used in these cases, and, in particular, the contact which should be zeroed is connected with ground. But as time passes, it becomes clear that, first of all, grounding does not ensure ideal zeroing, and secondly, in certain cases (such as portable devices) it cannot be used.

So, which device do we need to use for zeroing in different electrical systems? We will name it Nullifier. Nullifier must have small dimensions. Input resistance must be near zero, otherwise there will be no zeroing. It must not have output current. That is, it is desirable that the energy entering the nullifier as if disappears in it.

Let us think how grounding system works.

In popular literature one can find many explanations where the electrons that flow from the contact connected to the earth go to. But these explanations, (according to the author) do not always correspond to modern knowledge about electrical current [1]. Author often heard words like these: “One wire system is impossible. There is ‘second wire’ in these systems, it is earth”. But it is not correct. The linear resistance of ground (between two points on the surface) is great (50-1,000 Ohms per meter). Therefore, energy cannot be transmitted between two points through the ground.

Below is showed other, maybe unexpected, explanation of zeroing by earth.

Usually the grounding is a metal pin having about 1.5 m of length inside the ground (see Fig. 1). But on distance more than 10 m is impossible to detect traces of electric current.

2. Answer: AC Zeroing System—This Is an Antenna

The current which is being injected into ground is divided into the great number of weak currents. When depth increases, and the quantity of currents grows, hence, the amplitude of each current decreases to zero. It is known that current flows if there is a potential difference. But in grounding system there is only one potential (V), no difference of potentials like it is in a broken wire. Can current flows through broken wires? Yes, it can, for example, in a linear antenna. In case of monopole, the current stops at the end of radiator but its energy converted into the energy of the electromagnetic field. It means the energy path is not interrupted.

Now we can imagine grounding as a lot of very short monopoles, connected at the input of ground. It is known that monopole with height smaller than $\lambda/4$ has very small radiation resistance. In Ref. [2] is written in details about radiating resistor.

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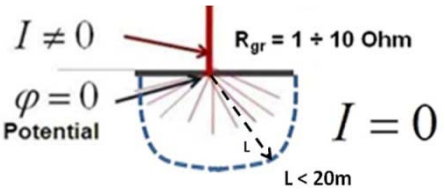

Fig. 1 Current in ground.

$$R_{rad} \approx 14(mh)^2 \Omega, \qquad m = \frac{2\pi}{\lambda}$$

This resistance tends to become zero with a decrease of h compared to the $\lambda/4$. Decreasing radiation resistance leads to decreasing radiating power, corresponding to [2]:

$$P_{rad} = R_{rad} \cdot I^2{}_{rms}$$

So, we can say that monopole with h < 5-10 m at frequencies 50 or 60 Hz has very small radiating resistance and radiation field density.

The monopole with height much less than the quarter of wavelength has a capacitive component [3]. But parallel connection of monopoles results to decreasing capacitive resistance also.

In other words, one can tell that grounding is an antenna consisting of a considerable quantity of monopoles, with length much smaller than quarter of a wavelength (note that wave length of electricity at frequency 50 Hz is 6,000 km).

So, nullifier can make without earth [4].

It must, consist of the electro-conductive rod with length about 0.5-2 m and of the set of wires or thin rods of approximately 2-5 m, connected to the central pin.

The nullifier in Fig. 2 was made for confirmation hypothesis that grounding is antenna. Increasing length of wires and their amount and using for compensating inductor lead to decreasing input resistance.

So, if this hypothesis [3] is correct, it is possible to make "nullifier" in the form of a device isolated from the earth and other conductive objects. So, we can conclude that in nullifiers using the ground, the input resistance tends to zero and the current entering the ground "disappears" due to its conversion to a very weak electromagnetic field.

3. Nullifiers with Ground Constructions

Described above zeroing process in grounding system allows proposing several nullifiers models. The main part of all nullifiers must be electrical system having minimal input resistance. Beside this input current must be decreased up to zero. It is showed different methods nullifiers building below.

First of all, it is possible getting nullifier as a grounding system, but with limited dimensions. As shown above maximal way for strong current can be no

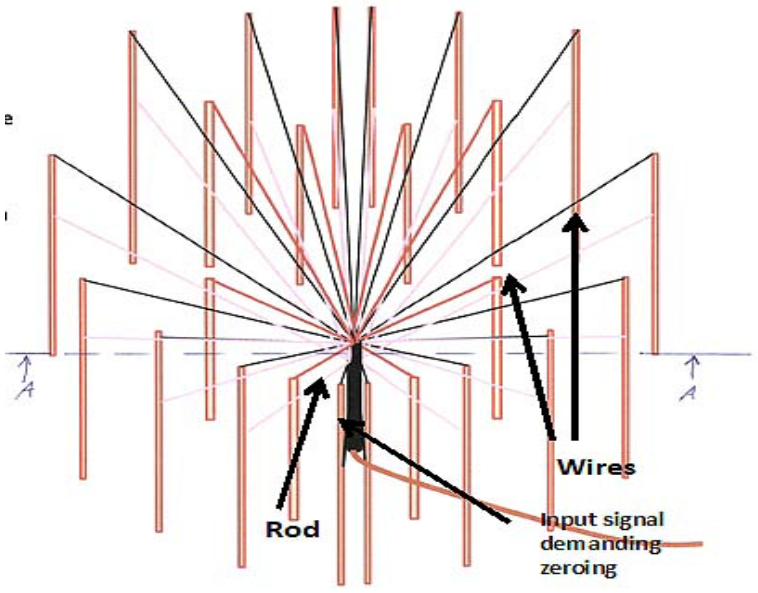

Fig. 2 Air antenna for zeroing.

more than 10 m. Two nullifiers using real earth were built. First (for large currents) consists of a concrete box (see Fig. 3). This box must be filled with soil and insulated from the ground. Its diameter is 12 m and height is 4 m.

The large box for nullifier was chosen to check the possibility of using several rods to build a nullifier in case of application for a powerful electrical system. As a result, an input impedance of less than 10 ohms was obtained (see Fig. 3). This type of nullifier can have small dimension if decreasing current is not too big.

For implementation of such nullifier in an experimental single-wire 6 kV system, a ditch of 3 m depth and 5 m long has been dug. Walls and bottom of the ditch have been covered by no conducting fabric of nylon type (see Fig. 4). If resistance of a nullifier is not

Fig. 3 Concrete box for nullifier.

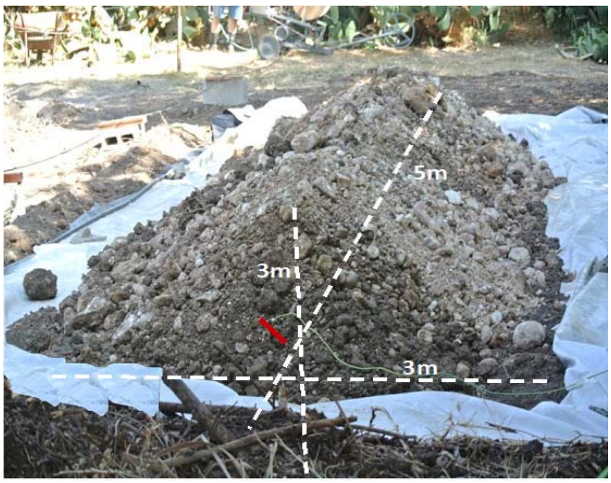

Fig. 4 Small nullifier.

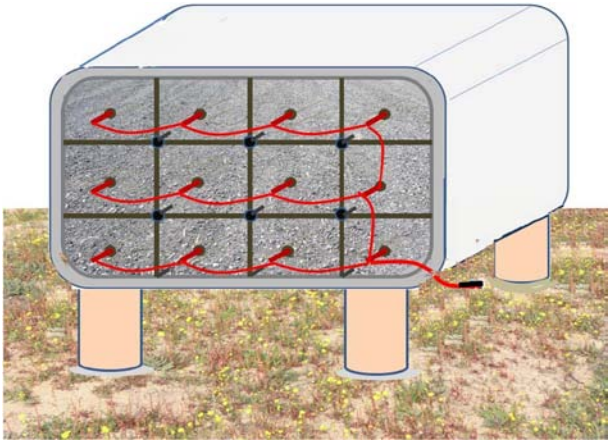

Fig. 5 Several parallel nullifiers.

low enough for a high-current system, it is possible just like in usual grounding to connect several nullifiers, as one can see in Fig. 5.

4. Nullifier with Current Zeroing

We propose here building methods of nullifiers which do not contain ground at all [3]. The current disappears here due to dividing it into two currents. One of the currents is inverted and then both currents add up. Inversion can be obtained with a half-wave delay line (see Fig. 6).

Obviously, such a nullifier can be used for a single-band high frequency signal or at its odd harmonics. At low frequencies, it is difficult to achieve the desired delay line.

Broadband zeroing option is with current sharing and summing. Suppose we have a delay line for the half-wavelength at the frequency F in the form of a ring (see Fig. 7). If you connect to this ring at point A, a wire from point B requires zeroing, and then at frequency F zeroing will be obtained. Obviously, two currents will add up at point A—one that comes from point B and the second that comes on line, passing through the ring. This is actually the same circuit as the delay line circuit. The sum of both currents at frequency F must be equal to zero. For a broadband signal, size X should make it possible to obtain the floor of the wavelength at all the required frequencies. At each frequency, the current will go along the line

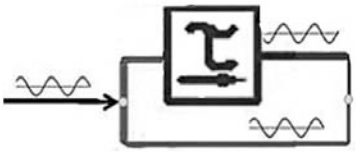

Fig. 6 Signal zeroing at single frequency.

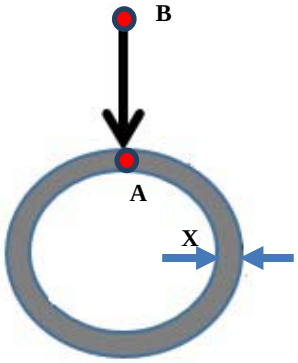

Fig. 7 A nullifier of the wide band antenna.

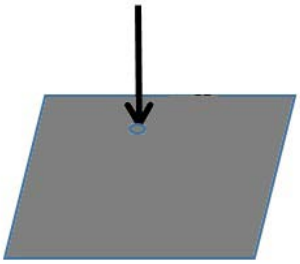

Fig. 8 A further nullifier example.

corresponding to several numbers of quarter wavelength of the lowest frequency. Therefore, since only for this frequency the ring resistance will be about zero.

The nullifier can be implemented also as a conductive plate such as a metallic layer of a Printed Circuit Board (PCB), as shown in Figs. 6 and 8. In this case, its perimeter must provide a minimum sum of currents entering the board and delayed in board. Fig. 9 shows an example of nullifier in the form of a board. And here it is desirable that the perimeter of the board would be at least odd numbers of quarter wavelength of the lowest frequency also. Using simulation was received value of radiation resistance at frequency 3.5 GHz equals 3.5 Om. On more big frequencies, this resistance slightly increases. The normal grounding has input resistance more. This nullifier principle is

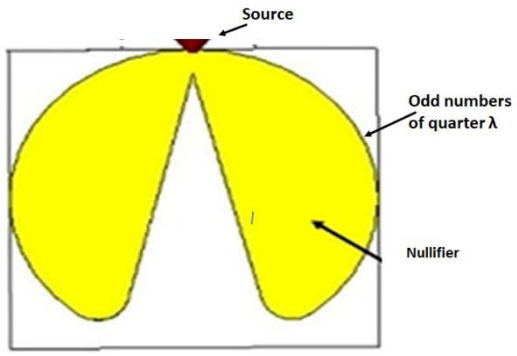

Fig. 9 Monopole with nullifier using metallic plate.

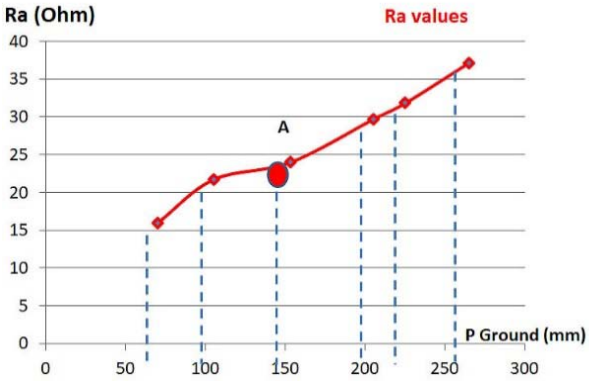

Fig. 10 Dependence of the value of radiation resistance on the length of the nullifier perimeter.

like the principle of normal grounding. So, it is antenna with small input resistance and very small radiation.

5. The Main Conclusions

For potential zeroing in any point is needed decreasing current from this point by electrical device with zero input resistance.

As this device can be multy monopole antenna with lengths much less than a quarter wavelength.

Other method of this device can be deviding curennt for two currents, inverting one of them and summing both currents.

Brief Afterword

Author filed a patent application in the U.S. Patent and Trademark Office to obtain a US patent on the nullifier.

However, the examiner of the US PTO Jeff W. Natalini rejected patent application based on an existing antenna which has nothing to do with it. In this antenna,

a point which requires zeroing is connected to a piece of metal. It is not defined at all what kind of a piece it is and what it is doing. Then author filed a complaint in the US PTO, but has not received any response.

References

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