

Tesla's Multi-frequency Wireless Radio Controlled Vessel

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Abstract – A review of the Tesla's contribution to dual-band wireless radio controlled vessel is presented. The intention of this paper is to describe multi-frequency remote controlled vessel using two transmitters and which operate a distant receiver which comprises two or more circuits, each of which is tuned to respond exclusively to the signals of one frequency and so arranged that the operation of the receiver is dependent upon their conjoint or resultant action.

Index Terms — Nikola Tesla, wireless communications, radio wave propagation, multifrequency control system.

I. Introduction

Tesla's patents, published and unpublished notes about wireless radio wave propagation is less known, and if known to some extent, it is usually wrongly interpreted. In 1898, Tesla decided to publicly demonstrate his radio system, again in a way typical of him, original and attractive. He constructed model boat that he operated by remote control, using radio pulses [1]. The boat sailed in a large pool in the great hall of Madison Square Garden in September 1898, during the First Annual Electrical Exhibition. It was a sensational demonstration; however, many had not grasped the essence of the invention. According to Tesla, that was the first robot, a representative of the new category of the machines that would be helpful to humans in a new way, as described in an article published by "Century Magazine" [2]. Tesla said that he had been working on the application of radio waves for remote control since 1893, when he published his basic radio plan.

For the model demonstrated in 1898, which he had constructed one year earlier, he applied a special technique with protected message transmission. It is possible that the two transmitters and special two wavelength receivers extremely resistant to interferences, are those that he described in his Colorado Springs Notes [3] and patented in 1903 (Patent no. 723,188). In archives of Nikola Tesla Museum there are a number of documents related to multi-frequency wireless radio controlled vessel.

In this paper, we present a review of the Tesla's contribution to multi frequency wireless radio controlled vessel.

II. Wireless Radio Controlled Vessel

Some work on remote control by radio waves Tesla performed in his laboratory on 35th South Fifth Avenue. When this laboratory burned down in March 1895 it was a terrible

blow to him and many experiments were stopped until the end of 1895 when he opened a new laboratory on 46th East Houston Street. In this laboratory he made, in his own words:

"Striking demonstrations, in many instances actually transmitting the whole motive energy to the devices instead of simply controlling the same from distance. In '97 I began the construction of a complete Automaton in the form of a boat, which is described in my original specification #613,809... This application was written during that year but the filing was delayed until July of the following year, long before which date the machine had been often exhibited to visitors who never ceased to wonder at the performances... In that year I also constructed a larger boat which I exhibited, among other things, in Chicago during a lecture before the Commercial Club. In this lecture I treated the whole field broadly, not limiting myself to mechanisms controlled from distance but to machine possessed of their own intelligence. Since that time I have advanced greatly in the evolution of the invention and think that the time is not distant when I shall show an automaton which, left to itself, will act as though possessed of reason and without any willful control from the outside. Whatever be the practical possibilities of such an achievement, it will mark the beginning of a new epoch in mechanics" [4].

The automation boat that Tesla constructed had "borrowed mind" and formed part of the distant operator who transmitted orders to it. But, to quote Tesla *"I purpose to show that, however impossible it may now seem, an automation may be contrived which will have its "own mind", and by this I mean that it will be able, independent of any operator, left entirely to itself, to perform, in response to external influences affecting its sensitive organs, a great variety of acts and operations as if it had intelligence. It will be able to follow a course laid out or to obey orders given far in advance; it will be capable of distinguishing between what it ought and what it ought not to do, and of making experiences or, otherwise stated, of recording impressions which will definitely affect its subsequent actions. In fact, I have already conceived such a plan" [2].*

Putting this reasoning in practice Tesla conceived the idea of constructing an "automation" which would mechanically represent him, but in a more primitive manner. Such automation, in Tesla's words, *"had to have motive power, organs for locomotion, directive organs, and one or more sensitive organs as to be excited by external stimuli."*

The principle he was developing in his first remote controlled boat was applicable to "any kind of machine that moves on land or in the water or in the air", and to show this to an audience he constructed a boat shown in Fig.1. According to Cheney and Uth, mining engineer John Hays Hammond, Jr. advanced \$10,000 to finance the wireless and robot demonstration at Madison Square Garden [5].

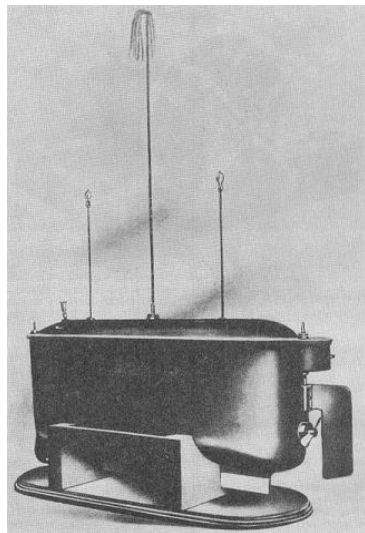


Fig.1. Remote control boat as in his patent No. 613,809

III. Chicago lecture on remote control

On his trip to Colorado Springs, the place of his new laboratory, Tesla stopped in Chicago and delivered a lecture before the Commercial Club under the title "On the Art of Teleautomatics" on May 13, 1899. There he also exhibited to the public a new six feet long remote controlled boat (Fig.4). This lecture was announced in the *Electrical Review*, N.Y., dated May 17, 1899. From numerous documents in the archives of Nikola Tesla Museum in Belgrade we can see that Tesla paid much attention to this invention but obviously did not find time to publish lecture and complete patenting a more advanced control system. In his lecture Tesla presented his invention in a very broad way starting with:

"Introductory – the Lecturer's Aim"

....Above all it is my desire to bring to your earnest attention a novel art which, in its elementary form, I have been fortunate to evolve and which, in the near future, when it shall have become generally known and brought to great perfection through the co-operation of many skilled man, will exercise a beneficial influence which will be universally felt and which will materially contribute to the furtherance of the cause of humanity.

His other themes were like *the Dead and the Living Objects, Birth and Death of Matter, The Down of the Era of the Atmosphere*, etc and at the end one short subchapter was devoted to remote control:

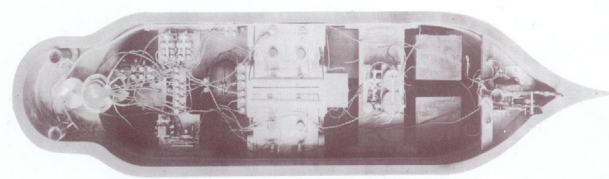


Fig.4. Second boat with remote control

3. THE ART OF TELEAUTOMATICS

Very few technical advances have created such widespread interest and elicited so animated a comment as this one. The reason is to be found in the fact that, like the discovery of gun-powder, it brought on a radical change in the aspect of those great forces and principles, upon which the political, and largely also the commercial supremacy of nations has rested for centuries...

It is impossible to form an adequate idea of the ultimate consequences of this new and beautiful art, but it is certain that it will afford a perfect means for attack as well as defense. By its use harbors may be rendered impregnable to the attack of the enemy, while torpedoes embodying its principles will be arms for attack immensely more effective than any yet invented. In view of this there can be no doubt, that the invention will be generally adopted in various countries, all the more readily as the present torpedoes on warships as well as those in harbors can be transformed into "Teleautomata" with little expense. What this would mean to a company owning exclusive rights need not be stated. A prominent designer is now engaged in constructing a small submarine vessel, which will be used in practical demonstrations before naval authorities".

Tesla's patent claims did not reflect all what he already knew at that time about new technique of remote control. His friends suggested him to omit quite a few things that he thought important in order not to overload the patent claims. In a letter to Miessner Tesla wrote:

"I would call your attention to the fact that while my specification, above mentioned, shows the automatic mechanisms as controlled through a simple tuned circuit, I have used individualized control; that is one based on the co-operation of several circuits of different periods of vibration, a principle which I had already developed at that time and which was subsequently described in my patents #723,188 and 723,189 of March, 1903. The machine was in this form when I made demonstrations with it in 1898 before the Chief Examiner, Seeley, prior to grant of my basic patent on Method of and Apparatus for Controlling Mechanisms at a Distance"[4].

In original USA patent No. 613,809 Tesla omitted to describe his "individualized control" which was a great step forward in providing safe and protected from disturbance control, as compared to simple mechanism control he described in his remote control boat patent. When at a later date, on July 16, 1900, he submitted patents "Method of

signaling”[1] and “System of Signaling”[1], to protect his method and system of “individualization”, prior to obtaining patent he had to clear matter with Fessenden in a patent rights dispute[6]. This document included statements in favor of Tesla by his assistant Fritz Lowenstein and secretary George Scherff. Finally, in March 1903 Tesla obtained patent after more than five years from the moment he had developed and experimentally proved the invention of individualization. The basic invention of “individualized control” is described in “Colorado Springs Notes 1899-1900”[3] on June 27, 1899.

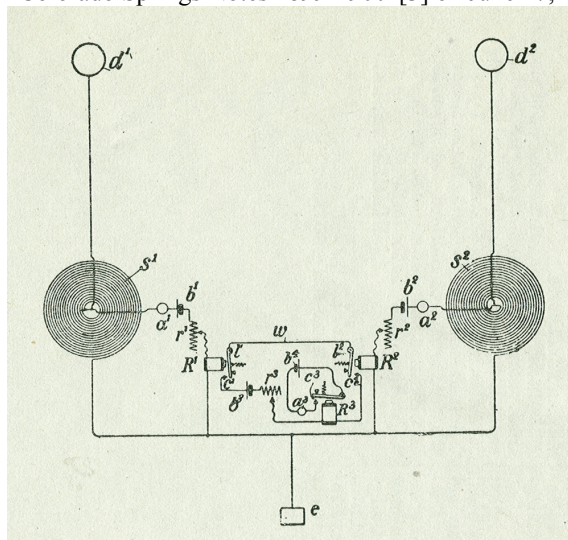


Fig.3. Tesla's receiver with “AND” circuit as a part of his multicarrier system

In the archive of Nikola Tesla Museum in Belgrade, among documents related to Tesla's remote control research, under the title “Improvements in the art of telautomatics”, prepared in the form of patent application, detailed explanation of radio control based on multicarrier system is presented. In this system Tesla proposed to use two (or more) transmitters of different frequencies which, when both operate, affect a special receiver responding only when both signals are received. The receiver is shown in Fig.3 and, at a later date it was recognized as the first “AND” circuit [7].

In material prepared for patent specification Tesla described multi-frequency remote controlled vessel. Figure 4 illustrates the multi-frequency wireless radio controlled vessel. A multi-frequency remote controlled vessel using two transmitters and which operate a distant receiver which comprises two or more circuits, each of which is tuned to respond exclusively to the signals of one frequency and so arranged that the operation of the receiver is dependent upon their conjoint or resultant action. The proposed, but unfinished and uncommitted patent Tesla opened with the words:

Be it known that I, Nikola Tesla, a citizen of the United States, residing at the Borough of Manhattan, in the City, County and State of New York, have made certain new and useful improvements in Methods of Controlling Automata at a Distance, of which the following is a specification,

reference being had to the drawing accompanying and forming part of the same.

In Letters Patent granted to me, bearing the number 613,809, I have described a novel art, for which the name "Telautomatics" has been suggested, and the purpose of which, is to control, from a distance and without artificial connection, translatory movements as well as operations of component devices or organs of individualized automata.

In order to secure the most satisfactory results in its practical applications, a number of requirements should be fulfilled, to wit:

- (1) The agent or energy employed for control should be in the form of impulses or oscillations of the requisite character and intensity;*
- (2) it should be transmitted to the automaton by effective methods and appliances;*
- (3) it should be collected in properly designed and organized receiving apparatus, efficient both in its quantitative and qualitative performance;*
- (4) the transmitted controlling impulses should, be non-interfering as well as non-interferable;*
- (5) the distant operator should be enabled to determine the position and course of the automaton with unerring precision....*

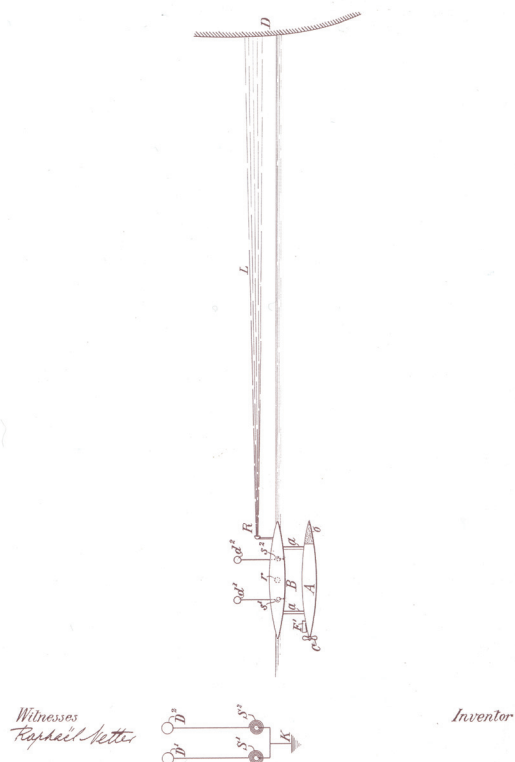


Fig. 4. Multi-frequency wireless radio controlled vessel

The subject of this application is an improvement intended to meet the last of the above named requirements and, briefly stated, it consists in the employment of a beam or beams of light or radiant energy, as will be hereinafter fully explained.

Calling again attention to the appended drawing, Fig. 4 represents, diagrammatically, an automaton which, in this special instance, will be assumed to float in the water, being either entirely submerged or only partially so, as indicated. It comprises two vessels or hulls A and B, rigidly connected by hollow flat bars a a. The lower and heavier vessel A is supposed to contain a reservoir of energy, such as a storage battery, and an electric motor or motors operating a propeller C and a rudder or fin F', thus giving to the automaton the desired translatable movement and direction. A device O, normally inactive, is furthermore provided which may be released or brought into effect at will, either by a special operation of the controlling mechanism or by impact against an obstacle. The upper lighter vessel or float B carries in its hold the individualized receiving apparatus controlling the working of the automatic engine in obedience to the impulses of the transmitter... To indicate a definite plan, I would refer to that which I have minutely described in the first of the patents here quoted and which can be readily adapted to the purposes of my present invention by any skilled expert. Indispensable in this connection is a lamp or reflector R, throwing a beam of light or radiant energy in the direction of a distant object D, which the automatic engine, on its peaceful or destructive mission, should reach without fail. The beam is supposed to be parallel to the long axis of vessel A, but need not be necessarily so, provided that it fulfils the essential requirement, which is to enable operator of guiding the automaton, from a great distance if need be, surely to its mark, avoiding all the limitations, errors and incertitude, heretofore inevitably attendant to such an attempt...

III. CONCLUSION

In this paper a short review of the Tesla's wireless radio controlled vessel has been presented. A multi-frequency remote controlled vessel using two transmitters and which operate a distant receiver which comprises two or more circuits, each of which is tuned to respond exclusively to the signals of one frequency and so arranged that the operation of the receiver is dependent upon their conjoint or resultant action has been described. Tesla built such a model but did not patent it, although he had prepared manuscript for it. Part of this manuscript that has been found in the archives of Nikola Tesla Museum in Belgrade is presented in this paper.

We thank Nikola Tesla Museum for permission to use some unpublished documents used in this paper.

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