On the Cover:

We indulge in a bit of whimsy with this photomontage of the Moon over Paris, symbolizing the European Space Agency's developing interest in mounting an ambitious program to explore Earth's satellite. The Moon was the first great goal of the United States and Russian space programs, but their exploratory interests drifted elsewhere in the solar system. Only the Japanese *Hiten* spacecraft and the *Clementine* technology demonstration project have investigated the Moon lately. ESA sees it as a target of opportunity that could establish the agency as a major space power.

Eiffel Tower: Alex Bartel/Zepher Pictures
Moon: Kerry Hurd, courtesy of Dennis Milon

From The Editor

Last year was a great one for The Planetary Society. We succeeded, perhaps as never before, in reaching out to the public and in shaping policy to support planetary exploration.

Comet Shoemaker-Levy 9's collision with Jupiter caught the attention of people around the world, and it served as a warning of what could happen to Earth should a celestial body collide with us. With our Jupiter Watch program, we focused that attention on the programs we support, and we are now working to expand research on comets and asteroids.

With Mars Together, we saw both the name and much of the content of a Planetary Society program adopted by the space programs of the United States and Russia. The dream of these former antagonists together tackling the exploration of another world never seemed closer to fruition.

But economic realities may undermine our victories. Public memory is short and it may be hard to raise funds for research. The Russian space agency may simply not have the money to fulfill its plans for Mars. We will have our work cut out for us this year if we are to see our projects succeed. —*Charlene M. Anderson*

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BACK TO THE FUTURE:

SETI Before the Space Age

by Steven J. Dick

The modern era of the Search for Extraterrestrial Intelligence (SETI) was inaugurated some 35 years ago, with the seminal paper by Giuseppe Cocconi and Philip Morrison in 1959 ("Searching for Interstellar Communications," *Nature*) and the Project Ozma search of Frank Drake in 1960. But even many SETI enthusiasts do not realize that this era of interstellar communication (as it was originally called) was preceded by a colorful era of interplanetary radio communication—an era filled with parallels, contrasts and perhaps even some lessons for those interested in the survival of SETI in its current incarnation.

The Radio Pioneers: Tesla and Marconi

Although the idea that visual signals might be sent to the Moon or Mars was common in the 19th century, it was the idea of radio communication between Earth and these bodies in space that caught the public fancy and the early interest of several radio pioneers. Heinrich Hertz, the German physicist who first demonstrated the existence of radio waves, died in 1894, too early to see the application of his work to even terrestrial communication. But two of his contemporaries, Nikola Tesla and Guglielmo Marconi, not only foresaw the use of radio technology for communication beyond Earth, but believed they had actually detected signals of intelligent origin.

Tesla, the Serbian-born American physicist and engineer, was the first to publish this idea, in 1901—and under remarkable circumstances. During experiments at his laboratory in Colorado Springs, Colorado, in 1899–1900, Tesla observed unusual electrical disturbances that "positively terrified me, as there was present in them something mysterious, not to say supernatural."

RADIO TO STARS, MARCONI'S HOPE

Inventor Says Waves of Ether Are Eternal and Can Reach Other Planets.

GETS STRANGE SIGNALS NOW

These, He Declares, Might Conceivably Have Proceeded from Other Worlds.

Special Cable to THE NEW YORK TIMES.

LONDON, Jan. 20.—The Daily Chronicle publishes an interview which Harold Begbie had with William Marconi, in the course of which the latter discussed the possibility of communicating by wireless with the stars.

Mr. Begbie asked him if he thought that waves of ether were eternal. Mr. Marconi replied:

"Yes, I do. Messages that I sent off ten years ago have not yet reached some of the nearest stars. When they ar-

Figure 1: Radio pioneer Guglielmo (William) Marconi reported receiving signals "which seemed to come from some place outside the earth." He wouldn't rule out the possibility that the signals came from another civilization, and many reports on his work appeared in the press. This article is from* The New York Times, *January 20, 1919.

Tesla knew of the electrical disturbances produced by the Sun, the aurora borealis and Earth itself; the new signals were more regular than any of these. "It was some time afterward," he reported in 1901, "when the thought flashed upon my mind that the disturbances I had observed might be due to an intelligent control. Although I could not decipher their meaning, it was impossible for me to think of them as having been entirely accidental. The feeling is constantly growing on me that I had been the first to hear the greeting of one planet to another."

Tesla went on to a busy, and then a reclusive, life and never followed up on this idea. Astronomers were skeptical, and the revival of interplanetary radio communication in a more sustained form came not from them, but from the great Marconi himself, by now world famous for his work in radio communication. On January 20, 1919, *The New York Times* ran a front-page article with the headline "Radio to Stars, Marconi's Hope." (See Figure 1.) Asked during an interview whether he believed waves of ether were eternal, Marconi replied, "Yes, I do. Messages that I sent off ten years ago have not yet reached some of the nearest stars. When they arrive there why should they stop?"

Comparing the weakening radio signals to a repeating decimal that never comes to an end, Marconi said this property of radiation "is what makes me hope for a very big thing in the future....Communication with intelligences on other stars...may some day be possible, and as many of the planets are much older than ours the beings who live there ought to have information for us of enormous value." Then, hesitating slightly, Marconi admitted he had

often "received strong signals out of the ether which seemed to come from some place outside the earth and which might conceivably have proceeded from the stars."

These ideas were repeated in more detail in the January 27, 1920, *New York Times,* where Marconi reported that Morse code letters occurred often in these signals but no message was decipherable. Because the signals occurred simultaneously in the London and New York receiving stations and because they were of equal intensity, Marconi inferred they originated at very great distances. "We have not yet the slightest proof of their origin," he noted, saying that it could be the Sun. It was not Marconi but the press that raised the contentious question about other planets being the source, to which Marconi replied, "I would not rule out the possibility of this, but there is no proof. We must investigate the matter much more thoroughly before we venture upon a definite explanation."

For the next few weeks, *The New York Times* followed up on the story almost daily, sometimes on the front page. Radio engineers were quoted as being highly skeptical that the signals emanated from another planet, especially from intelligence, and felt that they were atmospheric disturbances induced by the Sun. The United States Navy Department, with its advanced radio communications system, was reported to be keeping an open mind, with interest manifestly outweighing skepticism. Charles Steinmetz, the famous inventor and

***Figure 3: In 1924, at the suggestion of David P. Todd, the United States Army directed its radio operators to listen for possible signals from Mars. The Navy also joined in the effort. This illustration appeared in the October 1924 issue of* Radio Age.**

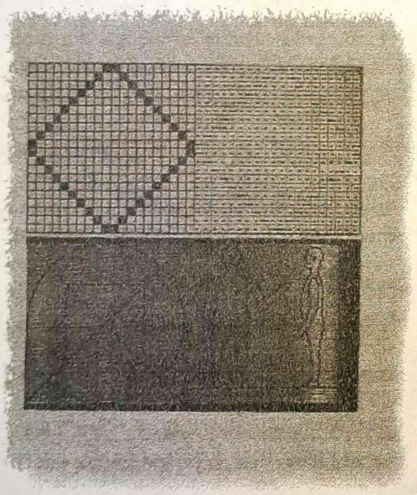

Figure 2: In 1920, Scientific American published this proposal for communicating by means of dots and dashes arranged in blocks. The top message uses strips of telegraph tape and graph paper. Below that, a larger number of blocks makes more complicated messages possible. This concept is similar to the later idea of formulating interstellar messages by determining blocks of pulses and spaces using prime numbers to set the dimensions of the array.

engineer, denied that the signals came from Mars but held that "if the United States…should go into the effort to send messages to Mars with the same degree of intensity and thoroughness with which we went into the war it is not at all improbable that the plan would succeed." C.G. Abbot, director of the Smithsonian Astrophysical Observatory, suggested that Venus was a much more likely source than Mars, since Mars was too cold and lacked water. And Elmer Sperry, head of the Sperry Gyroscope Company, boasted that his company could send a message to Mars using 150 or 200 Sperry searchlights adding up to a billion candlepower.

The debate reached continental Europe when the French Academy of Sciences agreed to judge a competition for a 100,000-franc prize "for the best means of making a sign to a heavenly body and the receipt of a reply." And no less a scientific icon than Albert Einstein was quoted as believing that Mars and other planets might be inhabited, but that Marconi's signals were due either to atmospheric disturbances or to experiments with other wireless systems. If intelligent beings on other planets attempted to communicate with Earth, Einstein added, he would expect them to use rays of light, which are more easily controlled. Einstein was thus an early proponent of optical SETI!

Two weeks later, *Scientific American* argued that while Marconi's conjectures should not be dismissed, there was absolutely no proof that Martians existed; it was unlikely that they would develop a Morse code as on Earth; they could not transmit over the 80-million-kilometer (50-million-mile) distance separating Earth and Mars; and radio stations at the Eiffel Tower and elsewhere, including those of the US Navy, had not heard the Marconi signals "although they have searched for them." Suspecting even the Japanese or "the Russian Bolsheviki, who have turned to radio as a convenient means of propagating their cause at home and abroad," the editors concluded nonetheless that "this matter deserves careful study when a scientist of Mr. Marconi's standing takes it so seriously." The following month *Scientific American* featured an article entitled "What Shall We Say to Mars?," which attempted to determine how knowledge might be communicated by dots and dashes in the absence of a common language (see Figure 2).

Marconi's interest in interplanetary communication apparently peaked during a trip from Southampton, England, to New York City aboard his floating laboratory, the yacht *Elettra,* from May 23 to June 16, 1922. *The New York Times* reported that he "spent the time crossing the Atlantic performing many electrical experiments, principally by listening for signals from Mars." Marconi admitted that "they might have come from any region in the universe where electrons are in vibration." It is notable, however, that when Marconi addressed the respected Institute of Radio Engineers and the

American Institute of Electrical Engineers on the subject of radiotelegraphy a few days after his arrival in New York, he discussed long-distance radio communication but had nothing to say on the subject of interplanetary radio communication.

Of all the reactions to Marconi's statements, none was more poignant than *The New York Times'* editorial "Let the Stars Alone," which argued that "even if it could be done one doubts it would be desirable....Quite possibly there are even yet more things in heaven and earth than are dreamed of in our philosophy, and it would be better to find them out in our own slow, blundering way rather than have knowledge for which we are unprepared precipitated on us by superior intelligences." This viewpoint also finds its parallel in the modern era.

David P. Todd, Balloon SETI and Other Schemes

In the midst of the Marconi flap, another thread of the story was developing: the idea of wireless interplanetary communication from a balloon. The prime mover in this daring enterprise, which combined an imaginative idea with a bold technology, was the well-known astronomer David P. Todd, director of the observatory at Amherst College from 1881 to 1920. As early as 1909, Todd had suggested that Martians might communicate with Earth using Hertzian waves, and that the most sensitive wireless receivers should be taken up in a balloon to diminish atmospheric effects. A skeptical *Scientific American,* anticipating in rudimentary form the problem of radio frequency interference (RFI) that frustrates modern SETI searchers, pointed out that about 2,000 wireless stations were scattered over the surface of Earth, that the Sun and Earth's atmosphere might also be sources of electrical signals and that it would thus be difficult to pinpoint the source of any supposed martian signals.

Nevertheless, in 1920 *The New York Times* reported that Todd, "after more than five years of preparation, during which time he has studied the proposition from every conceivable angle," had set the date of April 23 for a balloon ascent to try to communicate with Mars. Alas, we can only wonder what became of Todd's ambitious expedition. In subsequent days the *Times* reported only on a separate ground-based attempt at radio communication with Mars and offered a cryptic statement that while construction of Todd's balloon was progressing, the "experiment will be held in abeyance, however, until sanctioned by the U.S. Government." Once again, shades of recent SETI events!

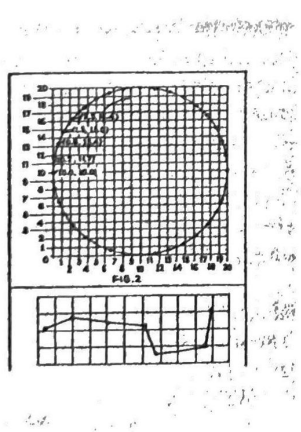

***Figure 4: In 1937, Harvard astronomer Donald Menzel proposed using number code to transmit "circle" and "dipper" to Mars. His proposal was published in the December 1937 issue of* Short Wave and Television.**

Though unsuccessful with his balloon experiments, by 1924 Todd pressed yet another bold project related to interplanetary communication. *The New York Times* reported that Todd had obtained informal assurances from the US Army and Navy that they would observe, as much as possible, a period of radio silence on August 22 and 23, when Mars was at closest approach. In an effort to obtain worldwide cooperation, Todd also discussed radio silence with the State Department and several embassies. In addition, Army and Navy radio operators would "listen in" for signals from Mars, and be "ready to translate any peculiar messages that might come by radio from Mars." (See Figure 3 on page 5.)

Department of Commerce officials said they too were ready to cooperate if asked. "Although officials were strongly skeptical as to success, they seemed to take the attitude that there could be no objection to giving communication with Mars a fair trial under the best possible conditions," the *Times* reported. Some experts were even more skeptical—too much so, we now know; the chief of the radio laboratory of the National Bureau of Standards declared that Earth's atmosphere would prevent any radio signals from reaching the ground!

On August 21, the Point Grey wireless station in Vancouver, British Columbia, reported having received unusual signals during the preceding week. Although the frequency was not given, "Four distinct groups of four dashes each came through the ether today," one operator had stated. The signals were in no known code, starting on a low note and ending with a "zipp," and neither a spark nor a continuous wave could have been responsible for the sounds. The following day the signals were heard again in Vancouver and reported to have been heard at the same time of day for more than four weeks. Moreover, the Associated Press reported that British wireless experts, using "a twenty-four tube set erected on a hill at Dulwich" had heard at a wavelength of 30 kilometers (18.6 miles) sounds "likened to harsh dots," but they could not be interpreted as any known code. Frank Drake and others have speculated that Tesla, Marconi and others might have been hearing "whistlers," low-frequency waves generated by lightning flashes that propagate along Earth's magnetic lines of force. These early attempts at interplanetary interpretations for unknown signals thus lend credence to the "Occam's razor" rule that mundane explanations should always be given priority over exotic ones.

Donald Menzel, Radio Amateurs and Radio Astronomy

In 1932, 10 years after Marconi's words on radiotelegraphy were published in the *Proceedings of the Institute of Radio Engineers,* Karl G. Jansky of Bell Telephone Laboratories reported in the same journal that he had detected a strange radio static that he could not attribute to any known source. This he interpreted in the following year as coming from beyond the solar system, a claim that was greeted with skepticism by most astronomers. (Occam's razor doesn't always work!)

Interest in radio communication with the planets, however, had not quite run its course. "The question of radio-communication with distant planets still holds supreme charm for all red-blooded radio experimenters," the editor of *Short Wave and Television* magazine (none other than science fiction pioneer Hugo Gernsback) wrote in the December 1937 issue. One of those radio amateurs happened to be Harvard astronomer Donald Menzel, who in the same issue wrote the article, "Can We Signal Mars by Shortwave?" Menzel noted that "the general consensus of opinion is that no very high degree of intelligent life exists in our solar system," and the thrust of his article was therefore not to propose the transmission or

receipt of actual signals, but to explore the question of whether we might in principle be able to communicate information via radio signals sent from beyond Earth.

If we received a radio message from Mars, Menzel argued, radio technology implied knowledge of mathematics and physical science, and mathematics was a natural starting point for communication. Using dots and dashes, one could begin by transmitting arithmetical problems and answers, to which the Martians would reply with their own. One could then advance to abstract numbers like pi, and the relative distances of the planets from the Sun. The alphabet could be transmitted by means of a series of paired numbers, coordinates on a graph (Figure 4). Proceeding in this way to more and more complex information, Menzel saw "no obvious limit to the information that could be exchanged."

The same issue of *Short Wave and Television* included the cautious opinion of radio pioneer Lee De Forest, the more imaginative interpretations of Tesla, and a remarkable analysis by American Telephone and Telegraph (AT&T) staffer Joseph L. Richey of the optimal wavelengths and the power required to send a signal to Mars (see Figure 5). Although Richey proposed that radiation between the infrared and 10-meter radio (as well as optical) wavelengths would be optimal for penetrating Earth's atmosphere, he concluded that communication with Mars was "economically and technically not feasible with present-day equipment." Such conclusions did not dampen the enthusiasm of radio amateurs, including pioneer Hiram Percy Maxim, whose book *Life's Place in the Cosmos* (1933) gave prominent coverage to *interstellar* communication. A generation ahead of his time in this proposal, Maxim simply had faith that some day the technology would be developed.

Figure 5: On the sending end (left and center): This illustration attempted to show the enormous amount of power—about 50,000 kilowatts—estimated necessary to transmit readable messages to Mars. It appeared in the December 1937 issue of Short Wave and Television. *At this time the first antenna for radio astronomy was being built.*

On the receiving end (top right): Hugo Gernsback gave this view of a Martian at his radio set (also in the December 1937 issue of Short Wave and Television*). Gernsback, often called "the father of science fiction," was the founder and editor of that magazine and many others, including* Amazing Stories.

Two Eras, Two Outcomes?

Like the modern era of interstellar communication, the era of interplanetary radio communication was led by innovative scientists with broad but practical interests. Tesla, Marconi, Todd and Menzel were all originals in their own way, not afraid to vent controversial ideas. All were well grounded in technical interests, and the interplanetary communication era was woven from those interests, though based on only the slightest of evidence. With time, the technical concerns increased in sophistication, beginning simply with unexplained signals and ending with concerns about optimal wavelengths, the effects of Earth's atmosphere, and power requirements. Prospective interplanetary communicators anticipated not only technical problems, but also philosophical, linguistic and cultural factors, only a few of which we have mentioned here.

But there are also major differences. The degree of technical sophistication is certainly one, as well as the manner in which the current debate is carried out. While a few papers appeared in *Scientific American,* debate was largely carried out not in professional journals but in newspapers. Though interplanetary listening projects were discussed and governmental cooperation was even secured in 1924, there was no real attempt to expend public funds on any project, a political process that dominated the NASA SETI program and led to its demise. Finally, we must not lose sight of the fact that despite their interesting discussions, Tesla, Marconi and others were mistaken in their interpretation of radio signals as artificial, a pattern that would-be interstellar communicators hope not to repeat. Needless to say, modern researchers would like to avoid the rather precipitous announcements of Tesla and Marconi to the media; history shows the inevitable result all too clearly. Our journey back to the future also demonstrates that while technical considerations are important, they should not act as an absolute constraint on thinking. Unbridled imagination is a dangerous thing, but it may also lead to the truth.

If we consider the era of interplanetary communication to be bracketed by Tesla in 1901 and Menzel in 1937, its life span is 36 years, almost the same duration as the current era of interstellar communication. It is true that now the entire universe awaits, rather than our own parochial solar system. But whether lack of detections, political will or funding results in a limited life span for modern SETI, and whether a century from now it will be seen as only a curious episode in the history of science like its predecessor, only the future will tell. Either way, both eras are a part of the venerable tradition of the search for humanity's place in nature.

Steven J. Dick is an astronomer and historian of science at the US Naval Observatory in Washington, DC. His book The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science *is currently in press at Cambridge University Press. This article is a much abridged version of a fully annotated paper given in the SETI sessions of the 44th Congress of the International Astronautical Federation, held in Graz, Austria, in October 1993.*

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Weird "Radio Signal" Film Deepens Mystery of Mars

Pictorially Recorded Messages Here Mere Tangled Mass of Dots and Dashes—Growing Wonderment May Bring Tenable Interpretation Theory.

The mystery surrounding strange radio signals heard in various parts of the world in the "nearest-to-earth" visit of Mars on Friday and Saturday was deepened yesterday, when the film in the special machine operated here to record such "signals" was developed photographically.

The result was a curious picturization of radio phenomenon. Thirty feet long and six inches wide, the chemically treated film showed, black on white, everything that was "picked up" out of the air in about 20 hours with a receiving apparatus adjusted to a wave length of 6,000 meters. The "messages" ranged from a fairly regular arrangement of dots and dashes, running the full length of the film down its left side, to pictures weirdly resembling a face, repeated at regular intervals on the right side of the film.

C. Francis Jenkins, inventor of the "radio photo message continuous transmission machine" used in the experiment in his laboratory, 1518 Connecticut avenue northwest, doubted that the recorded radio sounds had anything to do with Mars. He declared, however, that it was the most curious phenomenon ever photographed by his apparatus.

Mr. Jenkins was reluctant at first to have part of the film reproduced, fearing it might be regarded by the public as a hoax. He was prevailed upon, however, because of the widespread interest in the experiment, to permit its reproduction. He wished it understood that it was scientific curiosity, and not belief in the existence of intelligent beings on Mars, that caused him to use his machine for this purpose.

"I don't think the results have anything to do with Mars," Mr. Jenkins said. "Quite likely the sounds recorded are the result of heterodyning, or interference of radio signals. The film shows a repetition, at intervals of about a half hour, of what appears to be a man's face. It's a freak which we can't explain."

Dr. David Todd, professor emeritus of astronomy at Amherst college, who had enlisted Mr. Jenkins' cooperation in the widespread "listening-in on Mars" plan which he organized, was equally at a loss to account for the freak results. He regarded the film seriously, however.

"We now have a permanent record which can be studied, and who knows, until we have studied it, just what these signals may have been? But the important thing is to have a record.

"Three years ago Marconi was reported as saying he had heard signals from Mars. A few days ago he was quoted as saying he was too busy to listen to possible messages from Mars and that it was a ridiculous idea to do so. He changed his mind, and no one knows what he heard the first time. With our photograph, however, it is not a question of what one man heard. It is a permanent record, which all can study."

Dr. Todd said he had turned over about 18 feet of the developed film to William F. Friedman, chief of the code section in the office of the chief signal officer of the army. Friedman, the astronomer said, will try to decipher the strange signals.

Another strip of the film will be submitted today by Mr. Jenkins to Dr. J. H. Dellinger, chief of the radio division of the bureau of standards. The inventor hopes the bureau's experts may be able to determine the cause of the curious record. He had expected no more than a blank on the film, and said he is certain the record could not have been caused by a defect in operation of his apparatus. The film was the same kind used on other occasions, he asserted.

"As the film unwinds," he explained, "an instrument passes over it from left to right 50 times in every inch. An incoming sound causes a light to be flashed on the film, and this produces a black line."

Discussing the striking resemblance of some of the "faces" on the film to artists' and writers' conceptions of the theoretical Martians, as shown in novels and pictures, Dr. Todd said:

"The Jenkins machine is perhaps the hypothetical Martians' best chance of making themselves known to earth. If they have, as well they may, a machine that now is transmitting earthward their 'close-up' of faces, fences, buildings, landscapes and what not, their sunlight values having been converted into electric values before projection earthward, all these would surely register indelibly on the weirdly unique little mechanism."

COURT IS PETITIONED TO RESTORE CLOTHES OF WIFE OF CAPTAIN

Mrs. Blanche Kingston, Suing for Divorce, Seeks Trunkful of Gowns.

REQUEST ALSO IS MADE FOR TWO PET PARROT

Mrs. Marguerite S. Harvi Awarded $75 Month Alimony; Other Suits Entered.

Mrs. Blanche Kingston, wife of Capt. Arthur Kingston, United States marine corps, stationed at the Portsmouth, Va., navy yard, who was sued by her husband for an absolute divorce and in turn sued him for an absolute divorce, sought aid of the District Supreme court yesterday in her endeavor to recover a trunkful of Parisian gowns, two pet Santo Domingan parrots and some household furniture and other personal belongings which she says her husband has refused to return to her. At request of Alexander M. Brémer, counsel for Mrs. Kingston, Justice Siddons issued a rule requiring Capt. Kingston to appear Friday to show cause why he should not be compelled to return the property.

The court was informed that Mrs. Kingston was in need of her property and has repeatedly requested her husband to surrender it but, it was stated, he has refused, although the court was told most of the property is of no use to him. Mrs. Kingston was charged with misconduct at Quantico with Lieut. David R. Owen, also a marine officer, who was stationed at the nearby marine headquarters. Mrs. Kingston denied the charges and filed a cross-bill charging her husband with misconduct. Most of the personal property which Mrs. Kingston wants returned to her came from her mother, it was stated.

Capt. Kingston, in his answer to his wife's cross-bill, indirectly refers to assistance given his wife by her mother, in the matter of gowns and other things, as for "the satisfaction of her whimsical needs and fancies."

AMERICAN ROCKET SOCIETY
17th ANNUAL MEETING AND
SPACE FLIGHT EXPOSITION
PAN PACIFIC AUDITORIUM
LOS ANGELES, CALIFORNIA
NOVEMBER 13-18, 1962

AN HISTORIC REPORT ON LIFE IN SPACE: TESLA, MARCONI, TODD

by
C. D. Jackson and R. E. Hohmann
International Business Machines Corp.
Kingston, New York

2730-62

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INTRODUCTION

During the years 189?-1924 three experimental scientists, Nikola Tesla, Guglielmo Marconi, and David Todd (working independently of each other) observed laboratory data and related phenomena which suggested the possibility that they were monitoring interplanetary communications. During the same period (1899-1924) the Russian theorist Konstantin Tsiolkovsky deduced a model of an intelligence existing independently of terrestrial influence.

Tesla, Marconi, and Todd did not know that they were working with identical data, nor did they know that these data corroborated, in a quantitative manner, the theoretical model built by Tsiolkovsky.

This paper presents the investigations and experimental data of Nikola Tesla, Guglielmo Marconi, and David Todd. The data are first brought together in a historical model (1899-1924), and then are shown to be the natural complement of a current theoretical model (1959-1962). These data are then recommended for assembly into a quantitative model according to the theoretical outline described by Tsiolkovsky. *

Our purpose in this paper is to examine the original data of Tesla, Marconi, and Todd in response to a rhetorical inquiry presented by the Office of the Director of Defense Research and Engineering, asking: "What research is being done to keep abreast of the scientific advances of the past ... to see that there is not needless duplication of effort? Did the advances of the past fail to find application due to a lack of need for application at the time, or failure to have developed some technique or material ancillary to the application of the scientific advance?"[1]

* For purpose of economy-of-presentation, biographical details of Tesla, Marconi, Todd, and Tsiolkovsky are omitted and only as much historical background is used as is necessary to establish a chronology of events.

Tesla: Experiments in High-Frequency (1892-1907)

As early as 1892 Nikola Tesla had defined the use of the magnetic field of the terrestrial globe as a means of signal and energy transmission. [2] To reduce this idea to practice, Tesla designed and built equipment [3] capable of producing high-frequency currents, including the ability for tuning both transmitting and receiving coils to any desired frequency or wavelength. [4]

In a paper delivered at the 1893 meeting of the National Electric Light Association, Tesla stated that the purpose of his laboratory investigation was to know what is the capacitance of the earth, and what charge does it contain if electrified. "Though we have no positive evidence of a charged body existing in space without other oppositely charged electric bodies being near, "said Tesla," there is a fair probability that the earth is such a body, for by whatever process it was separated* ... it must have retained a charge as occurs in all processes of mechanical separation." [5]

Tesla continued his lecture, stating that the intent of his calculations was "... to ascertain at what period the earth's charge when disturbed, oscillates, with respect to an oppositely charged system or known circuit." [6] In effect Tesla was theorizing that the planet earth has a circuit-identification, i. e., a "signature" of its own, and that, given the proper equipment, he could broadcast this identity wholesale into the universe.

By 1896 Tesla had developed a prototype oscillator of sufficient capacity that he was able to demonstrate a "loop" circuit which was tied in with the earth's magnetic field. Tests of the oscillator at the Houston Street Laboratory (New York) in 1896 are best remembered for the "earthquake" tremors that were distributed over an area of twelve city blocks. Three years after the Houston Street effort Tesla was now ready to begin a full scale experiment. For this purpose he had constructed a special laboratory near Colorado Springs, Colorado.

The Colorado laboratory (Figure 1) was located on a vast expanse of plain, 2000 meters above sea level. The entire laboratory was designed in keeping with Tesla's plan to make the terrestrial globe a propagation device for the transmission of energy.

With reference to Figure 1, the mast is 280 feet high and is topped with a copper ball approximately three feet in diameter. The interior of the building was walled in a circular manner to accommodate the winding of a primary coil 75 feet in diameter. In operation, surges of power were driven, alternately, into the earth and outward from the top of the mast. Broadcast wavelengths were registered

* Tesla's views regarding the origin of the earth are derived from ideas proposed by Sir George Darwin (1845-1912), e.g., that the moon was torn from the earth by solar tides. cf. "Mysteries of the Moon," Dr. Harold Urey, New York Times, October 8, 1961.

at 2000 meters. [7] Banks of incandescent lights "plugged into" the ground 26 miles from the laboratory-site glowed and flashed throughout the experiments. Specialized instrumentation built to record the experiments at the Colorado laboratory was sensitive to the point that Tesla could detect and catalog every type of atmospheric electrical disturbance within a radius of 1100 miles.

It was during the tests conducted in Colorado in 1899 that Tesla detected the phenomenon which he described as an interplanetary communication. Speaking of the data that, unexpectedly, had registered on his instruments Tesla said that the signals took place "... periodically, and with such a clear suggestion of number and order that they were not traceable to any cause then known to me. I was familiar ... with such electrical disturbances as are produced by the sun, Aurora Borealis and earth currents, and I was as sure as I could be of any fact that these variations were due to none of these causes. The nature of my experiments precluded the possibility of the changes being produced by atmospheric disturbances .... Although I could not decipher their meaning, it was impossible for me to think of them as having been entirely accidental ... a purpose was behind these signals [8] ... they are the results of an attempt by some human beings, not of our world, to speak to us by signals .. I am absolutely certain that they are not caused by anything terrestrial." [9]

Following the experience in Colorado in 1899, Tesla became increasingly reluctant to release further details via the press and other public media. There is reason to believe, however, that the phenomenon Tesla recorded in Colorado, in 1899, consisted of three parts which, eventually, Tesla identified in terms analogous only to our present-day Information Theory. Tesla's efforts to respond in kind with a fourth part were therefore understandably obstruse to the point where "... for particular reasons," he said, the "... full technical report descriptive of the apparatus and results would be reserved for the records of the academies of science." [10]

Marconi-Todd: Observations and Experimentation (1899-1924)

On March 27, 1899, while Tesla was completing construction of the Colorado laboratory, Guglielmo Marconi concluded his first significant communication experiment: wireless transmission /receiving across the English Channel.

The achievement (transmission of the code-letter "V" from Wimereaux, France, to South Foreland, England - a distance of 50 miles) was the culmination of personal convictions and laboratory efforts closely resembling the equipment approach taken by Tesla. "Electrical actions or manifestations, "said Marconi in 1897, describing his basic patent, "are transmitted through the air, earth, or water by means of electric oscillations of high frequency". [11] And again, as with Tesla, Marconi's method of inquiry was to search for, and to duplicate the prototypes already existing in nature. [12] Experimental techniques, according to Marconi's view are "... no more than a simple consequence of observing and studying the means employed by nature to obtain her effects of heat, light, of magnetism across space. As the heat and light of the sun upon which depend the life of our planet are transmitted across millions and millions of kilometers of space, as the light of the most distant stars, as the electrical and magnetic perturbations of nature are manifested to us after having crossed the most immeasurable distances, it appeared to me [Marconi] that by adopting means similar to those adopted by nature, it should be possible to transmit these effects at our will..." [13] The correctness of Marconi's approach, i.e., finding his prototypes in the phenomena of nature, and implementing his findings with compatible devices, was aptly demonstrated on December 12, 1901, with the transmission of the first transatlantic message. Signals (a repetition of the code-letter "S") sent from the 25 Kilowatt station at Poldhu (Pold-ju) in Cornwall, England, were received via a kite-borne antenna flown from St. Johns, Newfoundland, a distance of 1800 miles. Following this success and the eventual establishment of an international Wireless Telegraph Company, Marconi once again turned to basic research.

To ensure personal independance, Marconi fitted out a floating laboratory (the 220 foot yacht Elettra). In this environment Marconi could work" ... at all hours of the day and the night, finding without delay suitable grounds for all kinds of experiments which would be difficult and complicated to carry out on land." [14] It was in September, 1921, aboard the Elettra, while conducting atmospheric experiments in the Mediterranean area, that Marconi detected the phenomenon which he described an an interplanetary communication. The first report of this experience was released by J. C. H. MacBeth, London Manager of the Marconi Wireless Telegraph Company.

"The signals," MacBeth said, "registered high in the meter band, although the maximum length of earth-produced waves at the time was 14,000 meters. The theory that the waves were produced by electrical disturbances was disproved by the regularity of the pulses. Although the pulses apparently consisted of a code, the only signal similar to earth codes was one resembling the letter "V" in the Marconi Code. Marconi himself expressed the belief that the signal had originated ... at some point in outer space." [15]

In his own discussion of the signals Marconi stated that he expected interplanetary communications to take the form of a "... transmission of pictures accompanied by a simple code." [16] In this statement Marconi anticipated by 3 years the results of the remarkable "listening" experiment conducted by Dr. David Todd, then professor of Astronomy at Amherst College, Massachusetts.

On the night of August 22, 1924, the planet Mars approached to within thirty-four and a half million miles. [17] Realizing that this close an approach would not come again until the year 2000, a "listening" experiment was arranged by Dr. Todd. At Dr. Todd's suggestion the U. S. Government, through diplomatic channels, requested that all countries with high-power transmitters turn-off their equipment for 5 minutes every hour from 11:50 P.M. August 21, to 11:50 P.M. August 23. [1]

and images (Figures 2 and 3). A most interesting comment here, and certainly beyond explanation, is Marconi's emphatic statement to the press (September, 1921) following his own experience of monitoring signals originating from an unknown point in space, that he fully expected inter-planetary communication to be in the form of "... transmission of pictures accompanied by a simple code." [32]

The final piece of information carried over from the historical model is the data representing signal-to-response time. Tesla's experience, as we have noted earlier, is identifiable with the Budden and Yates conclusion pointing to the existence of a system fixed in space relative to the earth and moving in orbit permanently with the earth, [33] and with F. D. Drake's theory of a passive observation system tuned to detect and to respond quickly to new sources of electromagnetic radiation. With Marconi and Todd, however, the signal-to-response time on both occasions was 22 years. And here, too, the historical model agrees most exactly with the contemporary theory that the probability of occurrence of life in the universe is best predictable on the basis of considering first those stars most resembling our own sun. The following table, prepared by Su-Shu-Huang [34] of the Institute of Advanced Studies, at Princeton, quantitatively reconstructs this theory:

NEARBY STARS ON WHOSE PLANETS (if any) LIVING BEINGS HAVE A BETTER-THAN-AVERAGE CHANCE TO DEVELOP

Star	Distance in Light Years	Spectral Type	Luminosity
Sun		G2	1.00
Epsilon Eridani	10.8	K2	0.34
Tau Ceti	11.8	G4	0.38

Signal-to-response times rated at the speed of light place the transmitted/monitored signals of Marconi and Todd exactly in the Epsilon/Eridani/Tau Ceti bracket.

The Antecedence of the Historical Model

The experience of Tesla, Marconi, and Todd were, respectively, personal and individual: there was no joint effort or comparative analysis either before or after the experience. In each instance a particular phenomenon was observed and recorded - and nothing more. As discrete events representative of isolated scientific phenomena distributed over the years 1899-1924, the value of each event at the time of occurrence was, therefore, impossible to ascertain. In composite form, however (as brought together in Figure 4), there comes into existence and without in any way distorting the individual events themselves - an inter-relationship of events. This inter-relationship (and the potential it carries) is the male factor that makes theory come alive with meaning. For this reason neither the events of the historical model not the data of the theoretical construct can, alone, be meaningful. The fact that the historical model came into existence first, and that the shaping of the theoretical model came 35 years later (beginning in 1959), is less important than the fact that each is a natural complement to the other.

Tsiolkovsky: An Advanced Theoretical Model

In the development of a theoretical model to give meaning to the historical events of 1899-1924 we have used the interim period of 35 years as a guarantee, i.e., an insulation, to ensure that the complementary matching is natural rather than collusive. We have presented an historic approach to the subject and, deliberately have avoided any attempt to interpret the data, reserving this subject for a specific paper. [35]

As a preliminary estimate, however, there are indications that the final interpretation will proceed more along the lines of Information Theory, and Image Processing, rather than in the conventional manner of reducing signals to alpha-numeric characters. The factors of guidance in this future effort are the intuition inherent in the advanced theoretical model proposed by Konstantin Tsiolkovsky (1857-1935). In the same manner that the model comprising the historical events of 1899-1924 is complementary to the opinions of the present-day scientific community, so too can we predict with some accuracy that a quantitative analysis of these same historical data will advance the state of the art to the level of Tsiolkovsky's theory of inter-planetary communication.

Even before Shannon's development of the Information Theory (1948), Tsiolkovsky had maintained that "... the simple repetition of signals is an obsolete method, convenient only in the initial stage of interstellar communication, in a form of short and simple signals," [36] Probing deeply for answers to the questions of entropy and negentropy, Tsiolkovsky worked with concepts that would not be related to signal theory until many years later with the advent of Wiener, Shannon, and Weaver.

"Science cannot avoid strange paths" was Tsiolkovsky's dictum. In this paper we have utilized the historic approach in an attempt to mark out the beginning of just such a path, and, insofar as possible, to remove some of the strangeness.

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Guglielmo Marconi, Patent Number 12,039 (England), July 2, 1897.

Compare with Pope Pius XII, Address to the Third International Communication Congress, October 12, 1955. The extraordinary achievements of science and technology "... are in reality nothing but the discovery and possession of forces and pre-existing laws which the Creator spread throughout the universe and which have operated actively since the beginning of creation."

My Father, Marconi, Degna Marconi, McGraw-Hill Company, New York, 1962, Part II, Chapter VII, p. 148.

Ibid, Part III, Chapter VIII, p. 231.

Condensed from an article by Vincent H. Gaddis.

16. The New York Times, September 3, 1921, 4:4.

17. Mars is, on the average, 200,000,000 miles from Earth, and, at the greatest distance, is 235,000,000 miles from Earth. On August 23, 1924, Mars and Earth were almost at the critical positions for a minimum separation of 34,648,000 miles.

18. The general description of this experiment is derived from accounts carried in the Washington Post, August 21-22, 1924; the New York Times, August 23, 1924; and from a further article by Vincent H. Gaddis.

19. The machine was a Jenkins Radio-Camera, regularly used for recording on a long photo-sensitive paper strip five-inches wide a radio-transmitted message or news copy sent by radio directly from a typewritten paper strip in the sending machine at the broadcasting station. In the camera a very small light source is arranged to traverse this photo strip in transverse lines, sixty lines to the inch. The longitudinal movement of the paper strip and the transverse movement of the light are both accomplished by an electric motor attachment, the motor being situated outside the light tight camera box.

The camera box was located in a dark room so that the camera could be opened and the paper strip put in and taken out without getting it light-struck. The adjustment of the motor speed was such as to move the strip about an inch every half hour.

The tiny light was attached to a radio receiving set located inside the dark room and the radio set adjusted to the longest wave length possible with this set (between 5000 and 6000 meters).

About 25 feet of the photo strip was put into the machine at about 1;20 P.M. Friday, August 22, 1924, and taken out Saturday somewhat later in the afternoon, it being discovered that the strip had all passed through when the camera was opened.

Any incoming radio signals which were within the limits of the wave length of the set would flash the tiny lamp, and these flashes would be recorded on the light-sensitive strip. The completed strip, which was developed on a motion picture film rack, contained a record of all incoming radio signals.

20. A detailed and quantitative analysis of the signals received by Dr. David Todd in 1924 is the subject of a paper currently in preparation by Mr. C. D. Jackson of the IBM Systems Analysis Group, in Bethesda, Maryland. This paper, entitled "An Experiment in Extra-Terrestrial Communication" will be offered to the American Rocket Society at a future meeting.

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22. F.D. Drake, Ibid

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35. See Note No. 20

36. Private Communication, September 4, 1962, from Dr. Alexis N. Tsvetikov, Department of Biophysics, Stanford University, Stanford, California.

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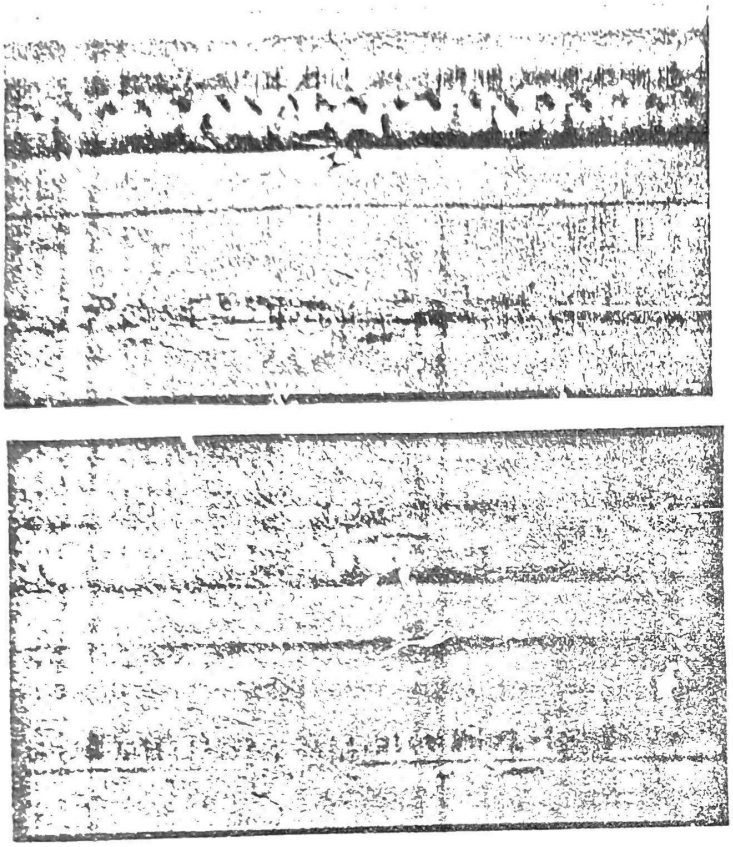


FIGURE 3

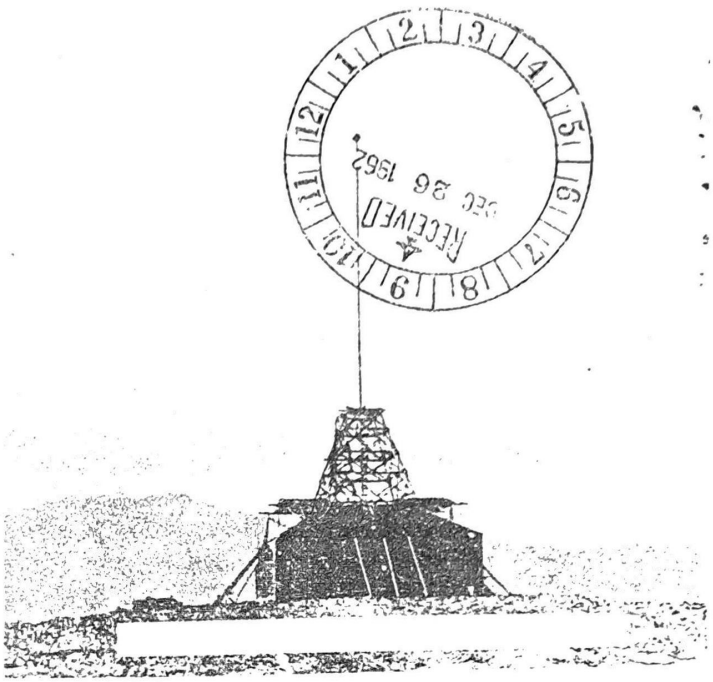


FIGURE 1

TESLA

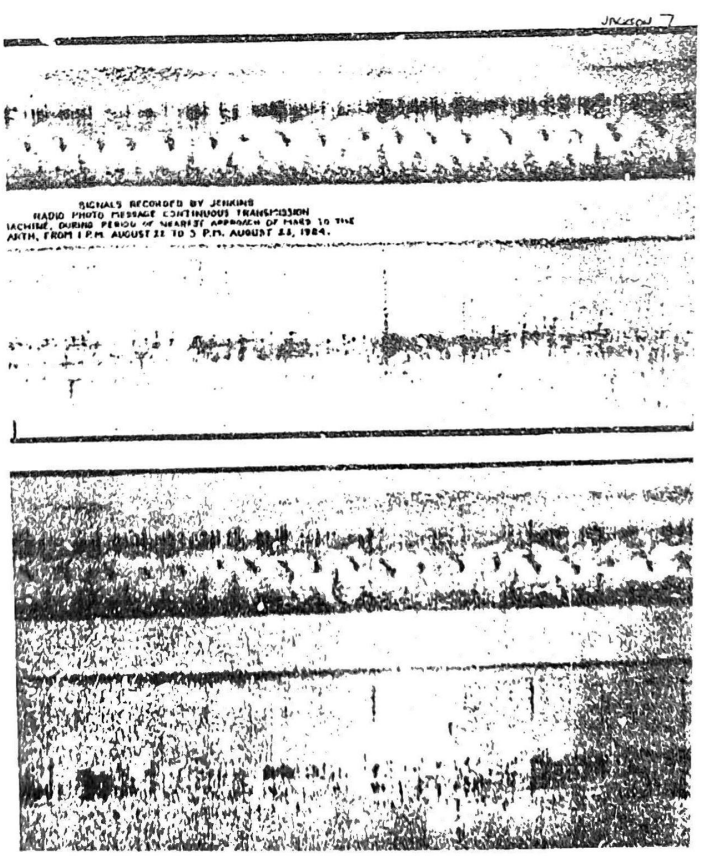
SIGNALS HEARD					
DATE	TYPE	FEATURE	DATE	TYPE	FEATURE
[illegible]	[illegible]	CAUSED TERRIFIC TOTAL ELECTRICAL DISTURBANCE; ARTIFICIAL NOISE, NOT INTELLIGENCE	1899	SINGLE PULSES	REGULARITY

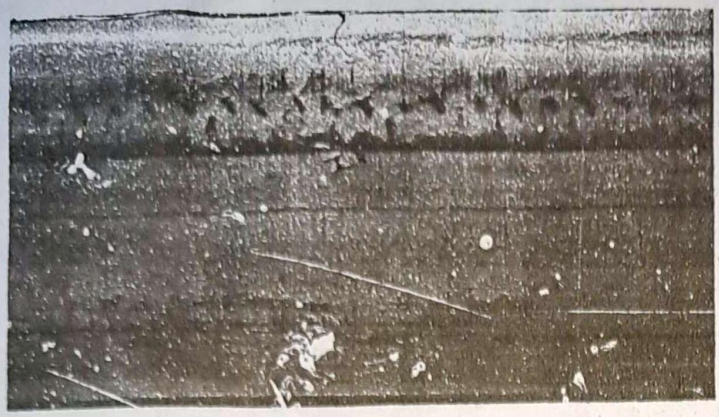
MARCONI

SIGNALS HEARD					
DATE	TYPE	FEATURE	DATE	TYPE	FEATURE
[illegible]	[illegible]	HIGH FREQUENCY REPETITION OF SAME SIGNAL	SEPT. 1901	HIGH FREQUENCY MORSE "S"	TIME SIGNAL TO RESPONSE-22 SECS
[illegible]	[illegible]	HIGH FREQUENCY REPETITION OF SAME SIGNAL			

TODD

SIGNALS HEARD		
DATE	TYPE	FEATURE
AUGUST 1924	HIGH FREQUENCIES MORSE "S" PHOTO ADDITIONAL CODE PHOTOGRAPHS	TIME SIGNAL TO RESPONSE 22 SECS





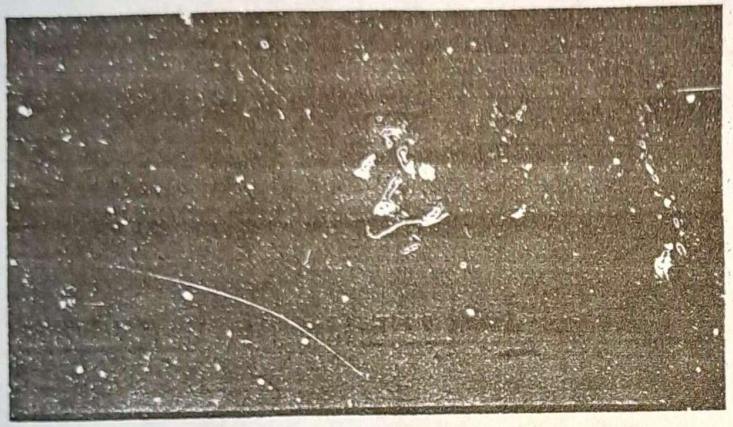


FIGURE 3

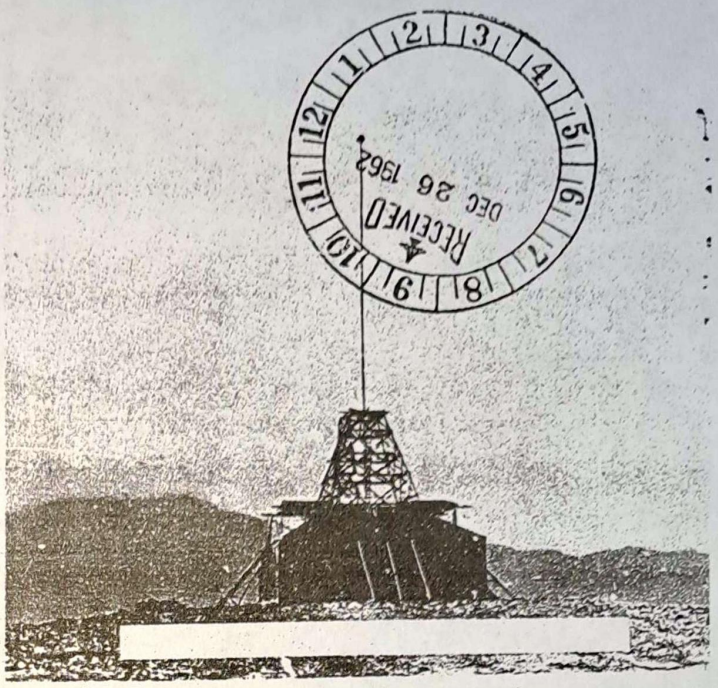


FIGURE 1

TESLA

TRANSMISSION			SIGNALS HEARD		
DATE	TYPE	FEATURE	DATE	TYPE	FEATURE
1899	HIGH FREQUENCY POWER BURSTS 50 MILLION VOLTS	CAUSED TERRESTRIAL ELECTRICAL DISTURBANCE; ARTIFICIAL NOISE, NOT INTELLIGENCE	1899	SINGLE PULSES	REGULARITY

MARCONI

SIGNAL TRANSMISSION			SIGNALS HEARD		
DATE	TYPE	FEATURE	DATE	TYPE	FEATURE
MARCH 1899 WIMEREAUX TO SOUTH FORELAND (50 MILES)	MORSE "V"	HIGH FREQUENCY REPETITION OF SAME SIGNAL	SEPT. 1901	HIGH FREQUENCY MORSE "V"	TIME: SIGNAL TO RESPONSE-22 YRS.
DEC. 1901 POLDHU TO NEWFOUNDLAND (1800 MILES)	MORSE "S"	HIGH FREQUENCY REPETITION OF SAME SIGNAL			

TODD

SIGNALS HEARD		
DATE	TYPE	FEATURE
AUGUST 1924	HIGH FREQUENCY MORSE "S" PLUS ADDITIONAL CODE, PLUS IMAGES	TIME: SIGNAL TO RESPONSE-22 YEARS