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I System for the Transmission and Reception of Telluric Electric Waves:

(1) Basic System

a) An electrical system is proportioned in such a manner so as to be attuned to electric wave propagation within the interior of the earth. The specific function may be the reception of naturally generated signals, or the transmission and reception of signals from an artificial, man made origin residing within the earth. These signals result from telluric currents. In general these may be called telluric electric waves.

b) This system is unlike previous systems in that the electrical apparatus involved are configured to match the generative process and the propagation characteristics of the telluric electric waves within the earth's interior.

This system is non electro-magnetic in its basic configuration. It is more an electro-static configuration. This results from the telluric waves having a non electro-magnetic character. The basic and compound telluric systems presented can be considered an advancement upon prior work of Nikola Tesla (1900) and Ernst Alexanderson (1919). In addition the systems presented can be considered improvements upon any existing methodologies or apparatus involving the reception of natural telluric impulses, communications or broadcasting systems utilizing electric wave propagation within the interior of the earth.

c) The system presented herein consists of various sub-systems configured to perform the reception and transmission processes. This may be divided into three distinct categories:

(1) That part which represents the space domain, or is distributed with respect to distance, so as to engender the actual electric wave. This is called the antenna sub-system;

(2) That part which represents the time domain, or the time period and duration, so as to respond to the specific telluric wave forms to be produced. This is called the network sub-system;

(3) That part which represents a scalar domain, effecting the attenuation and intensification of the electric waves in their passage through the other sub-systems. This is called the amplifier sub-system.

d) The antenna sub-system of the basic system is in electrical communication with the interior of the earth through multiple points of contact with the

solid mass of the earth. This sub-system is so configured as to be attuned to the complex propagation, directional characteristics, and phases of the telluric waves to be utilized in system operation. In conjunction with the ground contact an aerial structure, the purpose of which is to be isolated from ground, is utilized. This aerial exists in the form of a multiplicity of loaded transmission lines.

e) The network sub-system of the basic system is such configured as to produce or re-produce specific telluric wave forms in their time base behavior. Telluric wave forms of undesirable form are rejected by the network sub-system, however, this sub-system responds sharply to those telluric wave forms of desirable form. These wave forms can be directed to detection, recording or transducing devices, or they can be directed to the antenna for transmission.

f) The amplifier sub-system consists of electrical or electronic amplification elements, such as those found in carrier telephone applications. These elements may exist in conjunction with various filters or impulse limiters. These elements may be a conventional unit form or may be of a distributed nature throughout the basic system.

g) Each individual telluric wave system is adapted to match the existing geological conditions at the specific geophysical location to which it is applied. In addition each system must be specifically adapted for the purposes of broadcasting, communications, natural signal reception or detection of specific geological events. Each unit will have its own special requirements.

(2) Characteristics of the Antenna or Aerial-Ground Sub-System.

a) Telluric signals result from various standing waves and traveling waves which propagate within the interior of the earth. These waves have characteristic velocities, counter-velocities and directions of propagation. The antenna sub-system is proportioned to these specific telluric wave characteristics.

b) This antenna sub-system is developed on the basis of a <u>complex propagation in two dimensions</u>. This complex wave is a result of the superposition of a pair of electric waves, one wave with a <u>velocity</u> and another wave with a <u>counter-velocity</u>. This is a departure from conventional antenna developments. This antenna sub-system is loaded in such a manner so as to produce a <u>complex electric wave</u> along the transmission (aerial) structure of the antenna.

This wave is attuned to that wave produced within the interior of the earth. Hereby the antenna sub-system communicates with the telluric wave

through distributed points of contact with the solid mass of the earth. Each point of contact exists in relation with each individual loading element of the antenna transmission structure. Each point of contact can be a resistive element, a reactive element or a complex quantity of both.

c) This complex, distributed transmission structure is an analog structure. The antenna sub-system serves as an analog computer with the function of establishing an analogy of the conditions that give rise to the electric waves propagating within the interior of the earth. The antenna sub-system hereby reproduces that part of the standing or traveling wave within the earth as coupled through the multiple points of contact with the solid mass of the earth. This condition represents wave refraction between the antenna sub-system and the propagation within the interior of the earth.

d) The antenna sub-system utilized for telluric wave propagation is not an aerial as commonly understood, nor is the antenna sub-system an electro-magnetic radiator. The antenna sub-system consists of an aerial-ground structure in the application of telluric wave transmission and reception. It is configured to reject electro-magnetic wave transmission and reception. The aerial portion of the telluric antenna sub-system exists in distinction to the ground. This aerial structure operates in a manner such as a finite section of long distance carrier telephone line, carrying several loaded transmission pairs. These pairs are loaded and connected in such a way as to produce the required complex wave propagation in an analog manner. No coupling exists with this transmission structure and external electro-magnetic waves, which propagate in the space external to the solid mass of the earth. Hence the antenna sub-system is a non electro-magnetic structure incapable of the transmission and reception of external electro-magnetic waves.

e) The antenna sub-system is a wave structure analogous to the wave structure of the interior of the earth. This wave is a complex quantity in space, one quantity in the dimension of velocity (the real part) and another quantity in the dimension of counter velocity (the image part). Hence the complex wave propagation is not a simple velocity, now it is a more complex dimensional arrangement. (This is analogous to impedance as a complex quantity consisting of resistance, the real part and of reactance, the image part.) Electro-magnetic waves of a given velocity are superimposed upon magneto-dielectric waves of a given counter velocity resulting in a complex electric wave. For the transmission and reception of telluric electric waves the complex electric waves on the antenna sub-system follow the complex electric waves inside the earth. These two complex waves unite through the refractive multiple points of contact with the solid mass of the earth.

(3) Characteristics of the Network Sub-System

a) As it was with the antenna sub-system, the network sub-system serves as an analog now to the time domain; the period and duration of the transient electric waves of telluric origin. Like the antenna sub-system, the network sub-system serves as a form of transmission structure. Complex, transient, electric waves result from the superposition of two distinct waves, which each have distinct dimensions, now in time instead of space. Unlike the antenna, the network consists of lumped elements with no distribution in space. The network resembles a special form of electric wave filter, it being for selecting transient impulses rather than steady state waves. The complex electric wave developed by the networks is the superposition of high pass upon low pass electric wave propagations, these developing two distinct dimensions, that of unit time and that of per unit time. The wave developed by the network sub-systems analogous to the wave structure of the transient waves of telluric form.

b) The network can be developed as a pair of artificial transmission lines, a conjugate relation existing between each line. These artificial lines are configured as time domain analogs of the complex wave factors of the space domain antenna sub-system. The low pass characteristic is the analog of the electro-magnetic propagation of a given velocity. The high pass characteristic is the analog of the magneto-dielectric propagation of a given counter velocity. The low pass funtion is a condition of lagging phase, or increasing time delay with increasing frequency. A conjugate relationship exists for the high pass function. It is a condition of leading phase, or a decreasing time delay with increasing frequency. The superposition of this conjugate pair of functions results in the time-frequency relation for transient waves of telluric origin.

c) This electrical network so developed can be proportioned to an analog of, and thus respond to, or produce, a specific transient electric wave of telluric form. This electrical network can hereby be made to respond to a specific telluric signal, such as may be related to advance seismic warning, communications purposes, etc. Or, the electrical network can be made up so as to respond to a general variety of signals in a broadband manner. That network responding to specific signals may be called a discriminator, and that responding to a general variety of signals a band pass filter.

(4) Characteristics of the Amplifier Sub-Structure in the Scalar Domain

a) In the reception of telluric electric waves it is a condition that the received signals are of extremely small energy. Such signals are further attenuated in their passage along and through the antenna and network sub-systems. Also, in the transmission of telluric electric waves, substantial quantities of energy must be developed for the transmission. Therefore, some method must be introduced to intensify the telluric signals in their passage through the antenna and network sub-systems.

b) The introduction of unit amplifiers at the transitions between sub-systems serves as a basic method of signal intensification. These unit amplifiers may be electronic units utilizing vacuum or solid state devices. These electronic devices (vacuum tube or transistor) must be of a large gain-bandwidth product and possess a very small degree of intermodulation production.

c) Utilizing unit electronic amplifiers limits the telluric wave system through their uni-directional nature. That is, a receive only or a transmit only system. Hybrid transmission structures must be utilized for bi-directional or transponding systems. The use of unit electronic amplifiers produces a gain instability or drift in amplitude in the telluric wave system. Unit electronic amplification also produces undesirable modulation products from higher level signals upon lower level signals. Hereby distortion results and the consequent production of false signals. The principal advantage of unit electronic amplification is its adaptability to the inclusion of pass band and amplitude limiting functions and its simplicity.

d) An alternative method of amplification can be derived along the same method as the analog layout of the antenna and network sub-systems. The propagation through these sub-systems is derived by the geometric configuration of reactances and suceptances, that is positive and negative energy storage elements. These elements may be of a lumped or a distributed form, or both. Intensification of the telluric electric waves can be derived in an analogous manner to the propagation of the telluric electric waves. The intensification through the sub-systems is derived by the geometric configuration of resistances and conductances, that is positive and negative energy intensification elements. Again, these elements may be of a lumped or a distributed form, or both. Where the descrete reactance and suceptance elements relate to the storage and return of electric energy, the descrete resistance and conductance elements relate to the attenuation and intensification of electric energy.

e) The signal intensification element of negative resistance can be developed by a transfer resistance or transistor. Conversely, the element of negative conductance can be developed by a transfer conductance or vacuum tube. In the former the transfer resistance gains over the conductance loss and in the latter the transfer conductance gains over the resistance loss. Both may be utilized in an analog relation to the loss or gain of the electric wave generation or propagation within the interior of the earth.

f) The resistance and conductance elements of energy attenuation and intensification can be directly produced from the reactance and suceptance elements through parametric variation of the energy storage coefficients, that is the variation of the reactance or suseptance with respect to time. In this manner the energy storage element is partially converted into an energy intensification element. The variation is in proportion to a second wave derived from a second network. Such methods are known as a parametric amplification. Similar intensification effects may be achieved directly through the application of negative resistance devices such as tunnel diodes or negative conductance devices, such as multipactor vacuum tubes. These as two terminal devices can be directly incorporated into the antenna and network geometry.

g) Hereby three distinct methods may be applied to the intensification of received or transmitted electric waves in their passage through the antenna and network sub-systems:

1) Unit electronic amplification utilizing vacuum or solid state devices as transfer elements.

2) Distributed electronic amplification utilizing vacuum or solid state devices as either transfer or negative elements.

3) Parametric amplification utilizing electronic, static electrical or rotating electrical devices.

These methods of amplification may be applied individually or in combinations depending upon the overall system requirments.

II Telluric Transmission and Reception System Configurations

(1) Rejection of Interference

(a) The antenna-network system, along with a distribution of signal intensification elements represents an analog of the telluric electric waves, that is the complete system functions as an analog computing structure. This system allows the production or reproduction of the telluric electric waves within the earth as the result of the system functioning as an analog equivalent to the telluric waves.

(b) In addition to this analog attunement of the general system to the desired electric wave forms the system must also reject unwanted electric waves produced outside the solid mass of the earth. Undesired signals are produced or propagate in the atmosphere of the earth, such as lightning discharges, solar noise and manmade interferences. Because of refraction through the surface of the earth, both exterior and interior signals combine to a certain extent, resulting in interference.

(c) Rejection of these unwanted components of the electric wave propagation within the interior of the earth can be established through the use of a separate reference aerial structure, that is a rejection aerial. The inherent band pass characteristics of the antenna and network sub-systems can be also applied to the rejection of unwanted signals and interference. Rejection filter structures can be incorporated into the unit amplifier sub-systems for the elimination of manmade signals that give rise to interference effects in the telluric wave system.

(d) The rejection aerial constitutes a sub-system of a general system of telluric wave transmission or reception. The rejection aerial sub-system represents an electro-magnetic structure operating in the dimension of velocity. The function of this rejection aerial is to establish an electro-magnetic field of induction in the free space surrounding the general telluric system. Hereby the rejection aerial engenders the interference of non telluric origin.

(e) This rejection aerial sub-system is compounded with the aerial structure of the antenna sub-system as a form of counterpoise. Physically the rejection aerial is located over the aerial structure of the antenna in the manner of an overhead ground plane. The rejection aerial serves as a reference plane in the compound aerial-ground structure. As with the telluric aerial structure the rejection aerial consists of multiple, loaded transmission pairs. This loading is so proportioned to propagate electric waves at exactly the velocity of light in the same space as the compounded aerial structure.

Here the velocity of light has a unit value and is considered a relative condition of rest with regard to the telluric aerial structure. The transmission pairs are configured in such a manner that the rejection aerial establishes an external electro-magnetic field of induction, this in contra-distinction with the configuration of the telluric aerial, which rejects an external electro-magnetic field of induction. The rejection aerial is proportioned as an analog structure analogous to the propagation of electro-magnetic waves in the dimension of velocity, this numerically equivalent to the velocity of light.

(f) In conjunction with the rejection aerial sub-system is a rejection network sub-system, together forming a basic system for the rejection of electro-magnetic interference. This basic rejection system is analogous to the basic reception system in a conjugate form. Both serve as analogs of a given electric wave condition and serve as contrary analogs of each other. The resultant condition is the subtraction of the electro-magnetic interference from the telluric electric waves. The rejection network sub-system and the telluric network sub-system are compounded together to produce a subtractive process. This compounding is analogous to the compounding of the rejection aerial sub-system with the aerial-ground or antenna sub-system.

(2) Directional Characteristics of the Antenna Sub-System

(a) The telluric wave antenna sub-system and rejection aerial sub-system respond to or emit electric waves in a directional manner. The reception of or transmission of electric waves can be directed to or from specific geographical directions, while rejecting electric waves from all other directions. In general, the telluric antenna sub-system is directional broadside to the axis of the aerial structure while the rejection aerial sub-system is directional endfire to the axis of the aerial structure. However, these axes of propagation can be altered by adjustment of the aerial loading constants. The two aerial structures propagate in a perpendicular manner with respect to each other since their propagation factors are conjugate analogs.

(b) In telluric wave systems set up for transmission or reception, to or from a specific direction, a quadrature pair of aerial-ground sub-systems is utilized. Two systems exist in a perpendicular crossing over a central feed point. This configuration allows for the direction of operation to be determined by the relative phase difference between each system's network sub-systems. Hereby the compound aerial-ground structure consisting of quadrature basic systems can be directed by the network sub-systems. The network sub-systems of the pair of basic systems can be compounded with each other into a compound or common network sub-system. The directivity of this compound or complex aerial-ground system

hereby is derived from an analog function residing in the common network sub-system.

(c) For telluric wave systems configured for the transmission or reception of electric waves to or from a specific geographical location the quadrature compound systems are established in quadrature groups of four[1] in a space quadrature configuration. Hereby four distinct quadrature compound systems exist in a geographical square of extent exceeding the wavelength of the telluric electric waves involved. The specific geographical location is resolved within the relative phase difference existing between the network sub-systems of each individual quadrature compound system. These multiple network sub-systems can be united into a master network sub-system. The geographical location of this master system is hereby derived from an analog function residing in the master network sub-system. This master system can be adapted to the determination of the location of specific geographical events that produce telluric electric waves. The master network sub-system serves as a resolver for the indication or display of a specific wave originating at a specific geographical location. Such application is Advanced Seismic Warning Systems. Plan position indicating devices (P.P.I.) are incorporated into the master network structure.

(d) Each sub-system of the general, complex system for the transmission and reception of telluric electric waves serves as an analog function. Each sub-system serves as a direct or conjugate analog of each other sub-system. Each system serves as a direct or conjugate analog of each other system, the master system serves as a specific or general analog of telluric electric waves. The master system thus may serve as an archetype of telluric waves.

(3) Telluric Wave Systems for Specific Applications

(a) The principal application of the system for the transmission and reception of telluric electric waves is the development of Advance Seismic Warning, A.S.W. Telluric wave systems also may be developed for the broadcast of telluric electric waves to multiple reception locations or may be developed to communicate or transpond, with complimentary systems at specific geographical locations. Any waveform can be developed by a telluric wave system consistent with the archetype of telluric electric waves. This is limited only by the maximum degree of response possible with the physical structures that form the telluric wave systems.

(b) Advance Seismic Warning is one special condition of the general archetype. In this application of telluric wave reception an array of reception points are positioned around the specific geographic area

[1] groups of 3 in Scott configuration

producing electric waves relating to seismic activities. The electric waves produced in an advance time interval relating to a seismic event are of a specific, distinct waveform. This distinct waveform can be detected, apart from the general variety of telluric signal produced within the interior of the earth. This discrimination of seismic signals from the general activity is effected by the network sub-systems of the compound, complex systems described. In this application the network serves as a discriminator isolating the particular waveforms and directing these to the recording, indicating or transducing devices.

(c) The above system applied to Advance Seismic Warning is described in part by (2) (c). Multiple systems of reception are configured to pinpoint the specific location of an impending seismic event. For the applications of broadcasting, communication or general reception a configuration of sub-systems, basic systems, compound systems or compound complex systems can be developed.

III General Theory of Telluric Electric Wave Transmission and Reception

(1) Introduction

(a) The reception and transmission of telluric electric waves employs methods and principles unlike those found in conventional electro-magnetic wave systems. Electric wave propagation within the interior of the earth is of a character much different than that propagation in the space exterior to the solid mass of the earth. The space within the mass of the earth is complicated by various degrees of magnetic permeability, dielectric permittivity, conductivity and resistivity, all these of various magnitudes for various directions. Further is the presence of significant static magnetic and static dielectric fields of induction.

(b) With conventional electro-magnetic structures the principles of wave reception are equivalent to the principles of wave transmission, this is known as the law of reciprocity. In part this law can be applied to the various sub-systems that form the telluric wave systems. However, certain antenna configurations depart from the reciprocity law in that the propagation factor for reception must lag in phase behind the electric wave to be received, where as the propagation factor for transmission must lead in phase ahead of the electric wave to be transmitted. This situation is analogous to the alternating current induction machine. For a given frequency in radians per sec. of electric excitation to the field of the induction machine the frequency in radians per second of rotation must fall behind the excitation frequency for the induction machine to receive energy as a motor. Conversely the frequency of rotation must push ahead of the excitation frequency for the induction machine to transmit energy as a generator. In this situation the angular frequency of excitation is of unit value or represents a relative condition of rest. The angular frequency of rotation has a relative negative or positive, value for positive or negative power flow respectively. For the antenna the situation is the same. The lagging velocity for receive and the leading velocity for transmit, this relative to the velocity of the electric wave in the medium of transmission or reception.

(c) An important condition for the transmission and reception of telluric electric waves is a single wire or uni-polar connection to the solid mass of the earth. Electro-magnetic transmission and reception requires a multi-polar or multiple wire connection, two wire being common. It is required for telluric wave operation that the antenna sub-system be self referencing, that is the antenna sub-system not require grounding in the usual sense, since ground is now an active terminal. There can be no second wire since

there is nothing to connect it to. Hence, the need for a single wire or uni-polar antenna characteristic.

(d) In the transmission and reception of telluric electric waves two departures exist with regard to the transmission and reception of electro-magnetic waves:

1) The law of reciprocity is not applicable to the transfer of energy between the telluric wave and the antenna sub-system.

2) The boundary condition or circuit law is not applicable to the connection of the antenna to the solid mass of the earth.

(e) Such electrical conditions, once common in early wireless development, have become largely unknown. Two principal systems emerged from this era having the proper characteristics for telluric electric wave applications:

1) The oscillation transformer as developed by Nikola Tesla, 1900

2) The multiple loaded aerial as developed by Ernst Alexanderson, 1919

(2) The Oscillation Transformer

(a) The first development in the wireless transmission of electric waves was a telluric system based upon the application of an antenna sub-system known as the oscillation transformer. This transformer is a single winding coupled magnetically to an external resonant structure. Transformer operation resembles a constant current or ballast transformer. The single winding of the oscillation transformer resembles that of a simple reactance coil, however, only a single lead exists for communicating energy in and out of this coil structure. It is a single wire, uni-polar connection. The second lead of the coil is only connected to a small free space electro-static condenser.

(b) In the operation of the oscillation transformer the winding is not a simple reactance coil and magnetic field of induction. The dielectric field of induction now plays an important role, as energy now resides in the dielectric field in addition to energy residing in the magnetic field. In oscillation transformer operation the total energy divides evenly between the magnetic field and dielectric field of induction. The superposition of these two fields of induction give rise to complex electric waves. The oscillation transformer winding, thus operates as a wave guide structure, giving rise to electric waves through the exchange of magnetic and dielectric energy.