

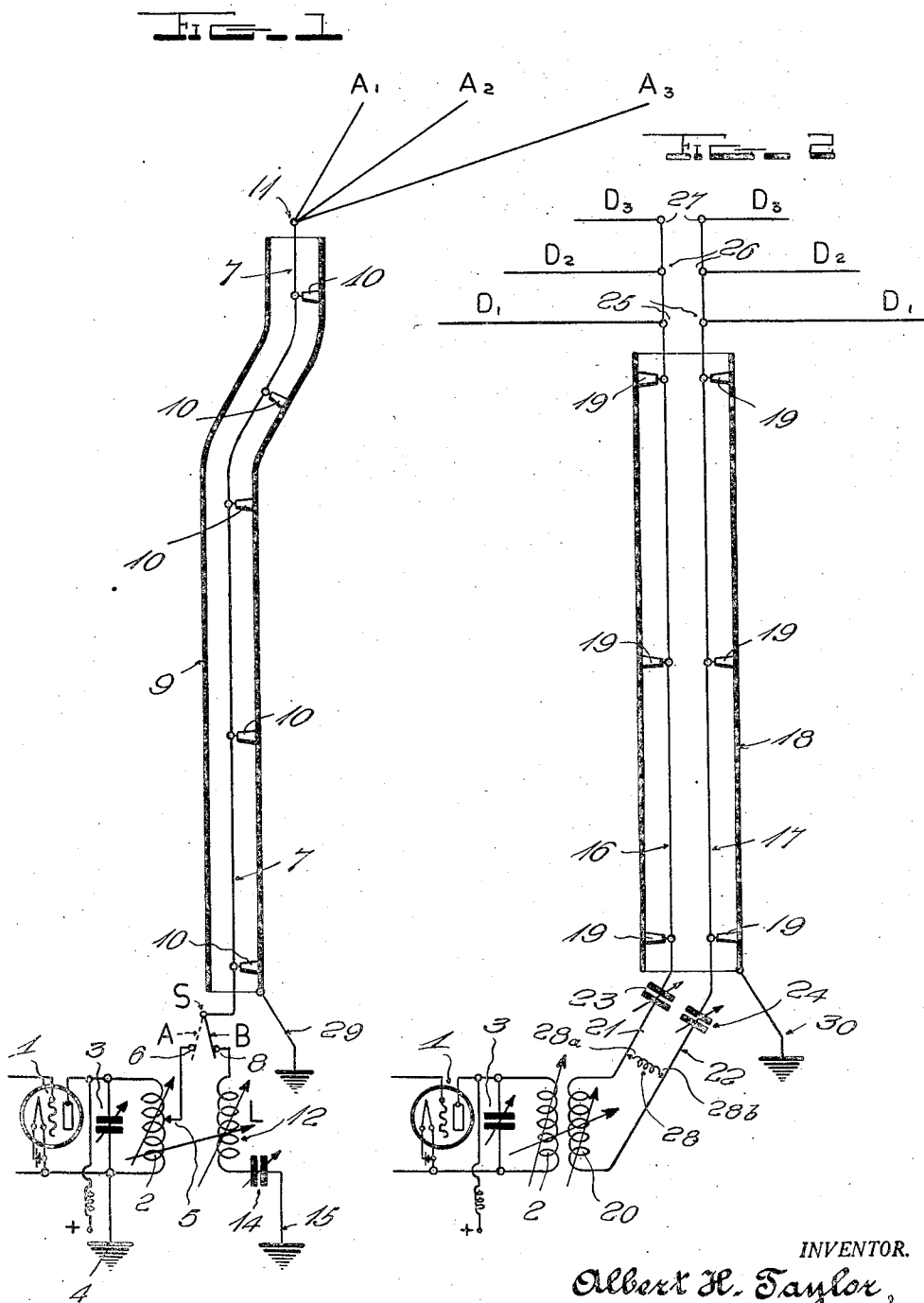
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SYSTEM FOR FEEDING COMPLEX ANTENNA SYSTEMS

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SYSTEM FOR FEEDING COMPLEX
ANTENNA SYSTEMS

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My invention relates broadly to high frequency signaling systems and more particularly to methods of feeding high frequency energy to radiating systems.

One of the objects of my invention is to provide a circuit arrangement for a high frequency signaling system in which multiple frequencies may be transmitted over a trunk conductor within a wide band of frequencies.

Another object of my invention is to provide a circuit arrangement for antenna systems for high frequency signaling in which different frequencies may be transmitted over the same trunk and radiated from antennae having different resonant frequencies within a relatively wide band of frequencies.

Still another object of my invention is to provide a circuit arrangement for a high frequency radiating system having means for feeding a multiplicity of antennae of different frequency characteristics through either a voltage feed circuit or a current feed circuit for radiating signaling energy at any selected frequency within a relatively wide frequency band.

A further object of my invention is to provide a circuit arrangement for a high frequency doublet transmission system in which a bridge inductance is provided between a pair of feed wires extending from the transmitter to a multiplicity of radiating systems of different frequency characteristics, the bridge inductance being adjustable along the feed wires for fixing the impedance of the feed system according to the transmitted frequencies.

Other and further objects of my invention reside in the circuit arrangement and method of feeding complex antenna systems as set forth more fully in the specification hereinafter following by reference to the accompanying drawing, in which:

Figure 1 diagrammatically illustrates a circuit arrangement for feeding complex antennae systems having either a voltage feed circuit or a current feed circuit interconnecting the high frequency transmitter with radiating systems of different frequency characteristics; and Fig. 2 illustrates the principles of my invention as applied to a high frequency doublet radiating system.

In ordinary applications, what I mean by "complex antenna system" will ordinarily be a system whose linear extent is relatively great compared with the wave length at which it is operated and which has two or more portions in which the wave energy travels with different

equivalent velocities. That is, in these two or more different sections the product of the distributed inductance per unit length by capacity per unit length will not be the same. Or otherwise expressed, the relations between physical length and resonant frequencies are not the same. It should be distinctly kept in mind that I am not here dealing with antenna systems which can be considered even as partially equivalent to localized capacities tunable by inserted inductances. I am dealing with frequencies higher, often much higher, than the fundamental frequencies, if there be such a thing in the complex antenna system in question. It is, of course, questionable whether such a system has a fundamental frequency. Any one section of it having the same equivalent wave velocity would have a fundamental frequency, but when two or more different sections are connected together a very complicated situation arises. In passing from a section of an antenna system having a given value of distributed inductance and capacity per unit length to another section having another value of distributed inductance and capacity, reflection of the wave is ordinarily produced at the point where the sections join. These reflections are most serious at high frequencies. At low frequencies it is often found that the antenna system tunes as a single system, and it follows that at such low frequencies the reflection must be negligible. On shipboard, radio transmitters are often located adjacent to large masses of metal making it necessary for the lead to the antenna to pass upwards from the lower regions of the ship through trunks which introduce high capacities from these leads to ground. It is often not practicable to send a man aloft to make changes at the point where the antenna proper is connected to the leads. The long leads or trunk are a necessity and can not be avoided.

My invention is directed to a method of supplying high frequency electrical energy through a relatively long extended lead or set of conductors to an antenna system radiating into free space, the particular object being to insure the adequate transmission of energy on selected frequencies within a relatively wide band of frequencies, such as from 4000 to 26000 kilocycles. My invention employs a high frequency transmitter, a relatively long trunk, a shield enclosing the trunk throughout its length and a multiplicity of antennae each of different frequency characteristics connected adjacent the extremity of the trunk. Such a trunk usually has capacity

of considerable value. A wide range coupling is provided between the high frequency transmitter and the trunk, which coupling is capable of being varied all the way from current feed to voltage feed to the trunk. It will be understood that with current feed a connection which is substantially earth or ground may be applied to the bottom of the system, that is, the lower end of the trunk conductor, or in the case of doublets, trunk conductor pair. In voltage feed this bottom of the system may be practically on open circuit and the voltage may be delivered through a small coupling capacity. The method of feed may be called current feed if the series inductance 12 is small, and the series capacity 14 (Fig. 1) is large or even short circuited. The method of feed may be called voltage feed if the series inductance 12 is large and the series capacity 14 is relatively small. The more common practice is to connect the trunk by direct conductive coupling to the output coil of the plate circuit of the last amplifier and transmitter when voltage feed is desired. Even in this case if the connection to the output coil is made very low on the coil near ground potential, a condition approximating current feed is obtained. The antennae which are connected to the upper extremity of the trunk are resonant at a number of different frequencies and it is the purpose of my invention to efficiently transfer any one of these frequencies from the high frequency transmitter to a selected antenna system or combination thereof, for radiation into free space. I avoid systems of adjusting the frequency characteristics of the radiating system of antennae adjacent the trunk head usually at its upper end for I have found that it is impractical to attempt to insert a unit at the head of the trunk in an effort to adjust the voltage or current distribution along the several antennae. The several antennae which connect to the head of the trunk in the system of my invention have different lengths so chosen that completely anti-resonant conditions will never occur. The several antennae are positioned only a few feet apart as represented in Fig. 2 or connect at the same point along the trunk as illustrated in Fig. 1, and differ in length within a range of two or three meters. With a transmitter capable of impressing voltage or current feed upon the trunk and having a relatively wide range of coupling, I have successfully transmitted into the same trunk line selected frequencies within a range of 14,000 to 72,000 kilocycles. By exploring the several antennae with contact meters I have found that the particular antenna which is highly anti-resonant takes very little energy from the trunk. The energy feeds into that antenna which most closely approaches the proper length and the presence of the auxiliary antennae therefore does not detract from the radiating characteristics of the antenna corresponding to the selected transmission frequency. With three antennae, one selected for the 8,000 kilocycle band, another selected for the 12,000 kilocycle band and another selected for the 16,000 kilocycle band, it will be seen that a wide range of frequencies may be covered actually permitting transmission on the 20,000 kilocycle band by a combination of the effects of two or more of the aforesaid antennae. Similarly, the 4,000 kilocycle band may be covered by one of the antennae or a combination of a multiple number of associated antennae. For intermediate fre-

quencies between the frequencies of the different antennae and their harmonics, the energy divides itself up between antennae and a tight coupling is necessary at the transmitter. Where one antenna is resonant to a particular frequency and another is anti-resonant, a strong coupling between the antennae does not result in interference in the transmission arrangement of my invention.

In a doublet transmission system, a single doublet or a multiplicity of doublets of different lengths may be employed which are resonant to different frequencies. The doublets may have antennae of different frequency characteristics connected adjacent the extremities thereof. I provide means for adjusting the impedance of the feed system by moving a bridge inductance to selected positions along the feed wires extending to the doublet antennae.

Referring to the drawing in more detail, reference character 1 designates the final stage of power amplification of a high frequency signaling system. The output circuit of this system includes the adjustable inductance 2 and the variable condenser 3 which may form part of the frequency changing system in the several stages of the power amplifier of the transmitter. One side of the output circuit of electron tube 1 connects to ground 4. Another connection is taken from the adjustable inductance 2 through the adjustable tap connection 5 to the contact 6 of the switching system which I have designated at S, the switch being movable to the dotted line position represented at A or to the full line position represented at B for completing connections between the extended trunk 7 and contact 6 or contact 8. The trunk 7 extends through the extended shield 9 which may continue for a substantial distance in a horizontal or vertical direction, the trunk 7 being at all times located in a central position within the shield 9 and insulated therefrom by means of insulators 10. At the head of the trunk 7 usually at its top the several antennae having different frequency characteristics are connected as represented at 11, the several antennae being indicated at A₁, A₂, and A₃.

In order to provide selectively for voltage feed or current feed, the output of electron tube 1 is delivered directly through inductance 2, through switch A to the trunk 7, or is delivered inductively from inductance 2 to inductance 12 and then through switch B to the trunk 7 and through series connected condenser 14 to ground 15. The method of feeding the trunk in this latter position is called "current feed" as distinguished from voltage feed obtained through the tap 5 on inductance 2 when switch S is in position A. That is to say, the frequency change system terminates in the primary inductance 2 coupled with the secondary inductance 12, which inductances are used in their normal inductive relation for effecting current feed to the trunk 7, or primary inductance 2 is used independently of secondary inductance 12 for effecting voltage feed to the trunk 7. The coupling between the transmitter and the trunk 7 is changeable according to whether the method of feeding the trunk is selected as voltage feed or current feed. Voltage feed may be selected when it is necessary to force a certain amount of energy into the system by a strong coupling at the bottom of the trunk when resonant conditions do not occur in the antennae system for the particular transmission frequency. How-

ever, other conditions of resonance current feed will be selected to more efficiently saturate a particular antenna and effect radiation therefrom. High frequency transmitters must be designed for both voltage and current feed if they are to operate when complex antenna systems and the range of coupling must be comparatively large. The antennae A₁, A₂, and A₃ have different resonant characteristics, and while current feed may be employed from a frequency thus selected to which some one of the several antennae is resonant, it is necessary to transfer connections to the voltage feed system when the transmitter is operated on a frequency to which the individual antennae may be anti-resonant.

In Fig. 2, I have shown a bilateral feed system comprising parallel extending trunks 16—17 enclosed within shield 18 and electrically insulated therefrom by means of pedestal insulators 19. The output of electron tube 1 which connects to the tuned circuit including capacity 3 and inductance 2 is inductively coupled to inductance 20, the opposite ends of which connect through the feed system 21—22 and condensers 23—24 to the trunks 16—17. The trunks 16—17 connect at their upper extremities to the plurality of doublets which I have represented at D₁, D₂, and D₃, connecting along the trunks at 25, 26, and 27, respectively. A bridging inductance 28 is provided in shunt to secondary inductance 20 and is arranged to establish variable connection with the feed wires 21 and 22 at the ends 28a and 28b thereof. The feed wires 21—22 constitute a transmission line interconnecting the secondary inductance 20 with the trunks 16—17 through variable condensers 23—24, and by shifting the position of inductance 28 along the transmission line, the impedance of the coupling circuit 20—23—24—28 may be selectively changed. The shields 9 and 18 are each grounded as designated at 29 and 30, respectively. The doublets D₁, D₂, and D₃ are individually resonant to different frequencies, and by a combination thereof intermediate frequencies may be radiated.

In both of the systems involving the open antennae A₁, A₂, and A₃, and the doublets D₁, D₂, and D₃, a large range of frequencies may be transmitted through a shielded feed system by means of the antennae array arranged to radiate the energy into space.

My invention finds particular application for the transmission of signals on different frequencies without change of the antenna system where the entire change occurs at the transmitter. I have found that the transmitter may be located remote to the antennae or doublets while securing satisfactory radiation at the transmitting antennae by the transmission of high frequency current from the transmitter over the feed wires and trunk to the multiplicity of antennae as herein set forth.

While I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna units each having different lengths and each

adapted to radiate a different frequency, a trunk system for conducting energy from said output coupling system to said antenna units, said trunk system operating to transfer energy over a frequency range embracing all of the frequencies generated by said transmitter to a selected antenna unit.

2. In an antenna system, a transmitter, a trunk connectible with the output of said transmitter, a multiplicity of antennae of different frequency characteristics connected to said trunk remote from said transmitter, and means connected to said transmitter for feeding selected frequencies to said trunk through a current feed circuit or a voltage feed circuit.

3. In an antenna system, a high frequency transmitter, a trunk line, a multiplicity of antennae connected to said trunk line, said antennae having different lengths and adapted to radiate different frequencies, and means connected to said transmitter for selectively feeding energy to said trunk line according to the particular frequency generated by said transmitter.

4. In an antenna system, a high frequency transmitter, a trunk line, a multiplicity of antennae connected with said trunk line said antennae having different lengths and adapted to radiate different frequencies, a coupling system interconnecting said transmitter with said trunk line, and means for connecting said trunk line to different portions of said coupling system for feeding said antennae according to a selected frequency generated by said transmitter.

5. An antenna system comprising a transmitter, a trunk line, a multiplicity of antennae connected with said trunk line, said antennae having different lengths, and adapted to radiate different frequencies, by a primary and secondary system disposed between said transmitter and said trunk line, and means for selectively connecting said trunk line with either the primary system or the secondary system.

6. In an antenna system, a transmitter, a trunk line, a multiplicity of antennae connected with said trunk line, said antennae having different lengths, and adapted to radiate different frequencies, a coupling system disposed between said transmitter and said trunk line, said coupling system including a primary inductance and a secondary inductance, and a switching device for establishing conductive connection between said trunk line and said primary or secondary inductance selectively.

7. In an antenna system, a transmitter, a trunk line, a multiplicity of antennae connected adjacent one extremity of said trunk line, said antennae having different lengths and adapted to radiate different frequencies, and selective means interposed between said transmitter and a position adjacent the opposite extremity of said trunk line and in electrical relation therewith for selectively impressing high frequency current upon said trunk line.

8. In an antenna system, a transmitter, a trunk line, a multiplicity of antennae connected adjacent one extremity of said trunk line said antennae having different lengths and adapted to radiate different frequencies, selective means interposed between said transmitter and a position adjacent the opposite extremity of said trunk line and in electrical relation therewith for selectively impressing high frequency current upon said trunk line, and an electrically grounded shield surrounding said trunk line sub-

stantially throughout the distance between said transmitter and said multiplicity of antennae.

9. In an antenna system, a transmitter, a trunk line, a multiplicity of antennae connected adjacent the upper extremity of said trunk line said antennae having different lengths and adapted to radiate different frequencies, coupling means disposed between said transmitter and the lower extremity of said trunk line, said coupling means including a primary inductance, a secondary inductance, and a switch device, and tap connections from each of said inductances to said switch device for the selective connection of said trunk line to either of said tap connections for the transmission of high frequency energy selectively over said trunk line for radiation from said antennae.

10. In an antenna system, a transmitter, a pair of trunk lines, a multiplicity of antennae having different frequency characteristics and connected with said trunk lines, coupling means between said trunk lines and said transmitter, said coupling means including a pair of feed wires, and means slidable along said feed wires for changing the impedance of said coupling means.

11. In an antenna system, a transmitter, a pair of trunk lines, a multiplicity of antennae of different frequency characteristics connected with said trunk lines, a coupling circuit extending between said transmitter and said trunk lines for feeding said antennae, said circuit including a pair of feed wires, and means adjustable with respect to said feed wires for controlling the impedance of said coupling circuit.

12. In an antenna system, the combination with a transmitter of a trunk line, means for selectively coupling said transmitter with said trunk line, and a multiplicity of antennae connected with said trunk line said antennae having different lengths and adapted to radiate different frequencies for the selective radiation of signaling energy at a frequency within the range of frequencies covered by said multiplicity of antennae.

13. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna units each having different lengths and each adapted to radiate a different frequency, a trunk system for conducting energy from said output coupling system to said antenna units over a frequency range including all of the frequencies generated by said transmitter, and a shield for said trunk system, said shield extending along substantially the entire length of said trunk system.

14. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna units each having different lengths and each adapted to radiate a different frequency, a trunk system for conducting energy from said output coupling system to said antenna units, said trunk system having a frequency range which includes all of the frequencies of any of said antenna units, said output coupling system being adapted to selectively apply voltage feed or current feed to said trunk system.

15. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output cou-

pling system for said transmitter, a plurality of antenna units each having different lengths and each adapted to radiate a different frequency, a trunk system for conducting energy from said output coupling system to said antenna units, a shield for said trunk system extending along substantially the entire length of said trunk system, and switching means interposed between said output coupling system and said trunk system selectively applying voltage feed or current feed to said trunk system.

16. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antennae each having different lengths and each being adapted to radiate a different frequency, a trunk line for conducting energy from said output coupling system to said antennae, said trunk line having a frequency range embracing the frequencies of all of said antennae, and a switch interconnecting said trunk line with said output coupling system for selectively applying voltage feed or current feed to said trunk line.

17. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna doublets each having a different length and adapted to radiate a different frequency, a pair of trunk conductors for conducting energy from said output coupling system to said doublets, each of said trunk conductors having one member of each of said doublets connected to one end thereof, each of said trunk conductors having a frequency range embracing the frequencies of all of said doublets, the doublet at the remote ends of said trunk conductors having the highest frequency characteristics and the succeeding doublets decreasing in frequency toward said output coupling system.

18. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna doublets each having a different length and adapted to radiate a different frequency, a pair of trunk conductors for conducting energy from said output coupling system to said doublets, each of said trunk conductors having one member of each of said doublets connected to one end thereof, a shield surrounding said trunk conductors substantially throughout their entire length and having a frequency range embracing the frequencies of all of said doublets.

19. In a system for radiating a plurality of frequencies, a transmitter for generating selectively a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna doublets each having different lengths and each adapted to radiate a different frequency, a pair of trunk conductors for conducting energy from said output coupling system to said doublets, each of said trunk conductors having one member of each of said doublets connected to one end thereof, each of said trunk conductors having a frequency range embracing the frequencies of all of said doublets, a pair of condensers connected respectively in each of said trunk conductors adjacent said coupling system, and a bridging inductance having its terminals slidable respectively along each of

said trunk conductors between said condensers and said coupling system.

20. In a system for radiating a plurality of frequencies, a transmitter for selectively generating a plurality of frequencies, an output coupling system for said transmitter, a plurality of antenna units each having different length and each adapted to radiate a different frequen-

cy, a trunk system for conducting energy from said output coupling system to said antenna units, said trunk system comprising a pair of parallel extending conductors each having a frequency range embracing the frequencies of any of said antenna units. 80

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