

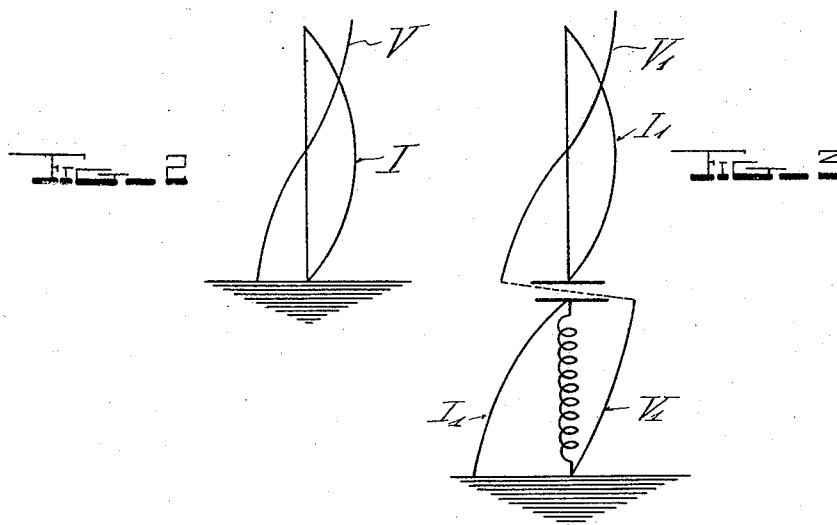
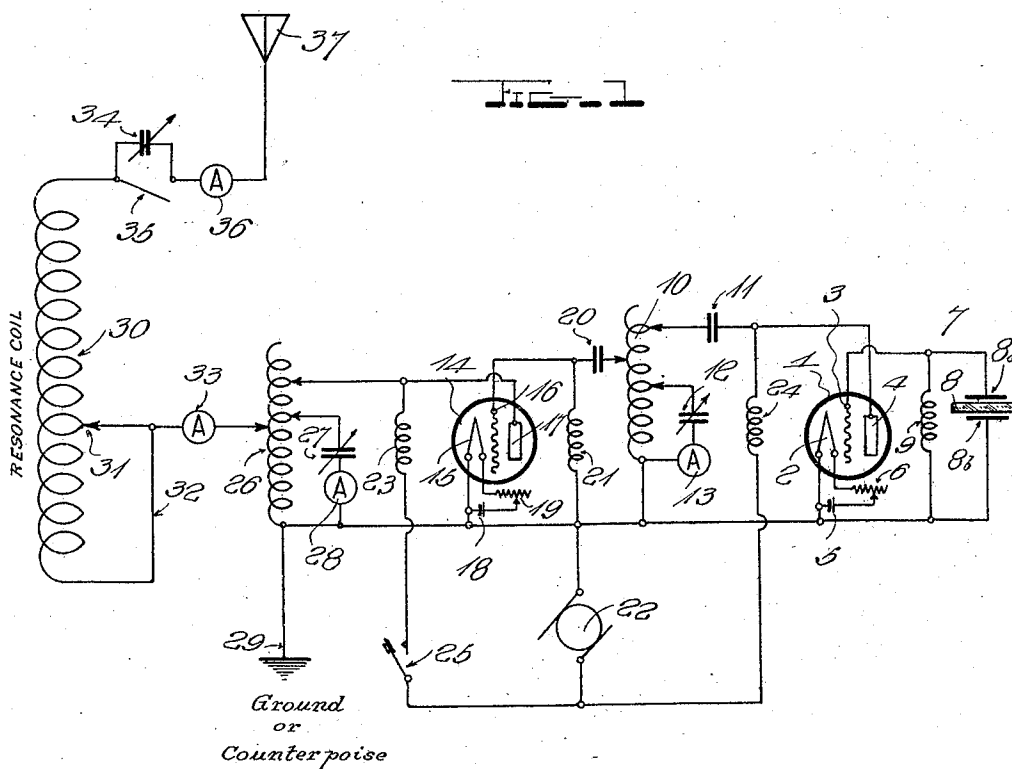
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CIRCUIT FOR PURIFYING HIGH FREQUENCY RADIATION

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CIRCUIT FOR PURIFYING HIGH FREQUENCY RADIATION

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My invention relates broadly to high frequency signal transmitting systems and more particularly to a circuit arrangement for purification of the radiation in high frequency signaling systems.

One of the objects of my invention is to provide a circuit arrangement for high frequency signal transmitters for eliminating undesired currents in the signal transmission circuits and preventing frequencies lower than the fundamental from reaching the antenna system.

Another object of my invention is to provide a piezo electric crystal controlled transmitting system having special circuit arrangements for eliminating the even harmonics of the crystal frequency and greatly reducing the odd harmonics for securing relatively large radiation at the crystal frequency by reducing losses on other frequencies.

Still another object of my invention is to provide a coupling system for a frequency multiplier circuit with an antenna system for delivering to the antenna the desired signaling frequency free of interference from undesired frequencies.

My invention will be more clearly understood from the following specification by reference to the accompanying drawing, in which:

Figure 1 illustrates the principle of my invention embodied in a piezo electric crystal frequency controlled transmitter; and Figs. 2 and 3 are diagrammatic representations of the current and voltage characteristics in high frequency signal radiating circuits, Fig. 3 showing the advantages obtained in the circuit of my invention over circuits heretofore employed and having characteristics as shown in Fig. 2.

The simplest way to operate an antenna on high frequencies is to work it close to the fundamental. Thus the current will be maximum at or near the base of the antenna and the voltage will be minimum at or near the same place. An ammeter in series with the antenna will then readily indicate resonance and the effective resistance of the antenna will be relatively low permitting a fairly

loose coupling to be used with the transmitter.

It often happens that such an antenna, unless erected in a clear open space not surrounded by absorbing structures, will not be an efficient antenna. The direction of maximum energy is, moreover, almost parallel to the ground whereas long distance work requires maximum use to be made of high angle components that come down after reflection from the Kennelly-Heaviside layer and produce the received signals. Therefore it is usually advisable to use a longer antenna and inasmuch as it is not always convenient to change the length of this antenna when changing waves, certain waves will be found for which the voltage and current distribution in the antenna is similar to that shown in Fig. 2.

The voltage may be high at the top and high at the bottom, whereas the current is maximum near the center of the antenna and zero at the bottom. The same situation arises in an antenna which is an integral multiple of the length of the one illustrated in this figure. Little or no current will be shown at the base of such an antenna and it is difficult to know when maximum energy is being put into it except by indirect observation. Moreover, the effective resistance of the antenna measured at its base is extremely high, which is the reason why from another point of view the antenna requires a very tight coupling to the transmitter.

In high frequency work many sets working on a frequency higher than 4,000 kilocycles, use a frequency multiplier in association with the oscillation system. If, for instance, the antenna is radiating 16,000 kilocycles, the chances are, at least with many types of design, that there will be another frequency somewhere in the set of 8,000 and still another at 4,000. That is, one or more stages of the power amplifier may be simultaneously acting as frequency multipliers. The factor of multiplication is sometimes 2, sometimes 3, and sometimes some other number although high efficiency is not ordinarily obtained when the frequency multiplication factor in any particular amplifier is higher

than 3. The result of this situation is that such a transmitter is not only prone to put harmonics into the antenna, but if the antenna is very tightly coupled to the transmitter, it may also put in some of these lower frequencies which might be called "sub-harmonics". This is an unusual situation and does not occur, except where the transmitters have frequency multipliers.

When a frequency is desired corresponding to a half-wave antenna such as is illustrated in Fig. 2, or if the antenna is an integral multiple of the length of such a one, it is relatively difficult to change the free wave length or wave lengths of the system by the addition of an ordinary inductance at the base of the antenna. With zero current at the base of the antenna the addition of a pure inductance without distributed capacity produces very little effect. The introduction of a series capacity is also of very little effect unless said capacity is extremely small, as a capacity so used brings about difficulties in coupling the system to the transmitter.

It is possible to put at the base of such an antenna, an inductance shunted by a variable capacity so that excitation of the antenna will result in a strong circulating current in this capacity-inductance parallel combination, but such a current is wasteful of energy. This method has been used, but it is not efficient, convenient, or easy to adjust.

I have discovered that it is possible to load the base of the antenna, not with a pure inductance nor with a pure inductance shunted with an adjustable capacity, but with an inductance containing intentionally a considerable amount of distributed capacity. Such an inductance operates as a resonance coil, since standing waves may be readily produced in it and indeed with very short overall linear dimensions.

Reference character 1 designates an electron tube having cathode 2, grid electrode 3 and plate electrode 4 arranged in oscillatory circuits for the generation of high frequency oscillations. The cathode 2 is heated from a suitable source 5 under control of rheostat 6. The input circuit of the oscillator is represented at 7 under control of the piezo electric crystal circuit comprising the piezo electric crystal element 8 disposed between conductive plate members 8a and 8b in shunt with respect to the choke coil 9. The output circuit of the electron tube 1 is connected through condenser 11 with inductance 10, which is tuned by means of condenser 12 with an ammeter 13 connected in circuit therewith for observing the current values in the circuit. A power amplifier or frequency multiplier system is connected to the tuned circuit including inductance 10 and comprises the electron tube 14 having cathode 15, grid electrode 16 and plate electrode 17. The cathode 15 is heated from battery 18 under control of rheostat 19.

A connection to the input circuit of electron tube 14 is made through condenser 20. The output circuit of the power amplifier connects through inductance 26 to ground or counterpoise 29. Inductance 26 is tuned by means of variable condenser 27 disposed in circuit with the ammeter 28. The plate voltage for the oscillator tube 1 is supplied from a source 22 through choke coil 24. The plate supply for the power amplifier or frequency multiplier tube 14 is obtained from the generator 22 through keying circuit 25 and choke coil 23. A choke coil 21 bridges the input circuit of the power amplifier tube 14 between grid electrode 16 and cathode 15 for insuring the proper potential for the grid of the electron tube 14. The resonance coil is designated at 30 having a tap 31 thereon which is connected to the end of the coil through conductor 32 and to the inductance 26 through a lead which includes ammeter 33.

The antenna may be connected direct to the top of the coil or it may be coupled loosely to it through a small variable condenser 34 arranged to be shunted by means of switch 35 as shown. The rest of this coil may be adjusted by a movable tap preferably with the arrangement as shown in the drawing, to short circuit the unused part of the coil, thus hindering standing waves from being developed in the lower portion of the coil. The upper portion of the coil then is the portion which is made sharply resonant to the desired frequency. This frequency and this one only develops a high potential at the top of the coil, which potential is exactly what is desired for coupling to an antenna of extremely high resistance which is connected either directly to the top of the coil or by way of a small coupling condenser 34 while the meter 36 shown in series with the antenna may still indicate little or no current. A meter placed as shown at 33 in series with the resonance coil 30 will show a considerable amount of current and can be readily used to indicate resonance. The potential distribution when the condenser is used is shown in Fig. 3, the potential being low at the bottom of the coil and current being high. This makes the system very convenient and easy to handle, permits loose coupling to the transmitter, and due to the great sharpness of tuning at the resonance coil 30 not only takes out the even harmonics, but greatly reduces the odd ones also, and prevents altogether the frequencies lower than the fundamental reaching the antenna.

I have found the circuit arrangement described herein particularly suitable for high frequency transmission. The interposition of the resonance coil prevents losses due to spurious currents both of higher and lower frequencies than the one desired. By observing a transmitter circuit with a wave meter with the resonance coil in the circuit

and removed from the circuit, I have found that the transmitting circuit without the resonance coil therein shows the existence of considerable antenna current of frequencies other than the one desired, which current is normally part of the loss in the circuit, but with the resonance coil inserted in the system the radiation is purified by the elimination of these undesired frequencies, with a resulting increase in the radiation of the desired frequency.

While I have described my invention in certain particular 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 high frequency transmission system, a source of waves capable of supplying waves of different frequencies including waves of a desired frequency, a radiating conductor having a length equal to one half the wave length of the desired waves, and means for coupling said source to said conductor for the radiation of waves of the desired frequency to the substantial exclusion of waves of other frequencies comprising a connecting link having an electrical length of an odd multiple of the quarter wave length of the desired waves.

2. A system as described in claim 1 further characterized in that a condenser is inserted between said connecting link and said radiating conductor.

3. In a high frequency transmission system, a piezo crystal controlled master oscillator, means for developing harmonics of the wave produced by said oscillator, said means including a circuit tuned to the frequency of one of said harmonics, an antenna system comprising a radiating conductor one half wave length long connected to ground or counterpoise through a resonance coil having an effective electrical length of an odd multiple of one-fourth wave length of said one harmonic, and means for transferring energy from said tuned circuit to said radiating conductor through said resonance coil.

4. In a high frequency transmission system which comprises a source of waves of desired and undesired frequencies, a radiating conductor and a transmitting link having an electrical length equivalent to an odd multiple of a quarter wave-length of the desired frequency, the method of suppressing the radiation of the undesired waves, which comprises applying energy to said radiating conductor at an intermediate point thereof, loading the base thereof with an inductance and a considerable amount of distributed capacity and establishing in said radiating conductor standing waves the voltage nodal point of which is at the base thereof.

5. In a high frequency transmission system which comprises a source of waves of desired and undesired frequencies, a radiating conductor and an inductance coil connected thereto having a relatively large distributed capacity between the turns thereof, the method of substantially suppressing the undesired frequencies and radiating only the desired frequency, which consists in establishing in said inductance coil a condition of resonance to the undesired frequencies, and in fixing a voltage nodal point at the base of said radiating conductor.

6. The method as set forth in claim 5, which includes the further step of characterizing the electrical length of said inductance coil so that it becomes resonant to an odd multiple of a quarter wave-length of the wave of desired frequency.

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