O. C. ROOS.

ELECTROMAGNETIC WAVE TRANSMITTING SYSTEM.

APPLICATION FILED NOV. 4, 1918. RENEWED JAN. 19, 1921.

1,369,281. Patented Feb. 22, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

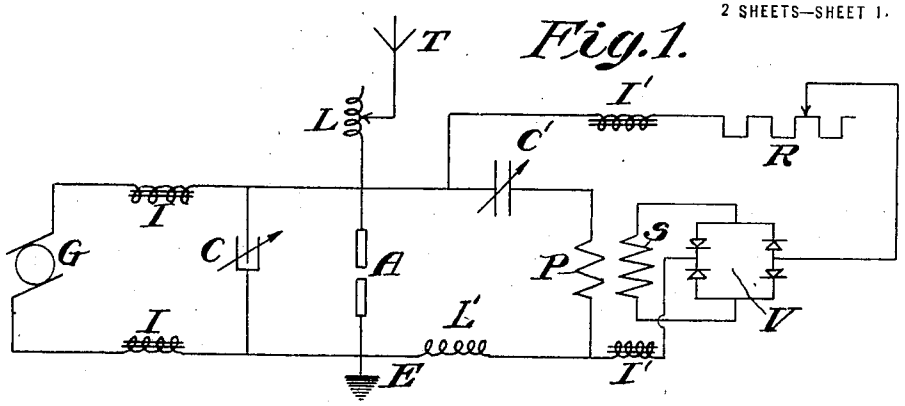


Fig. 2.

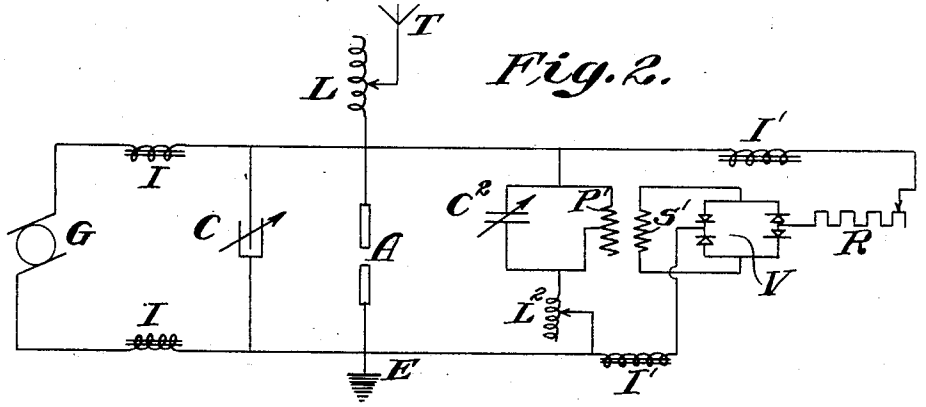
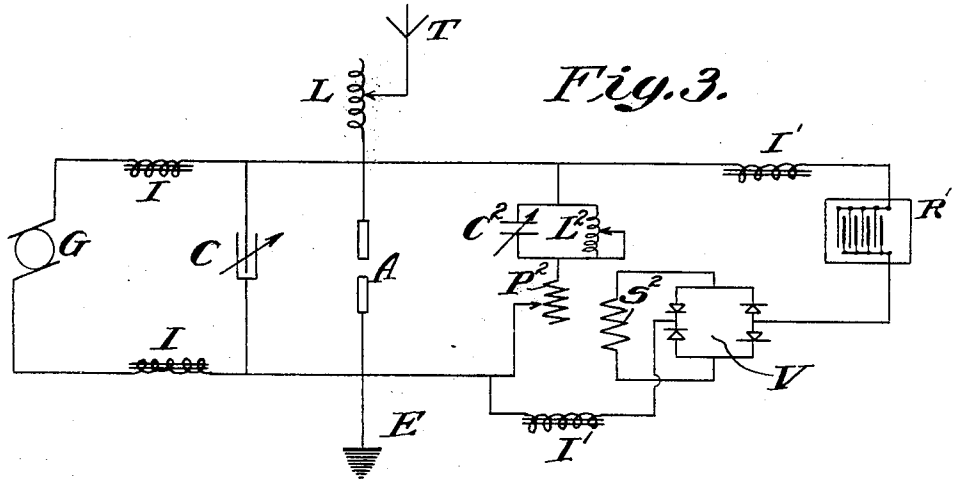


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

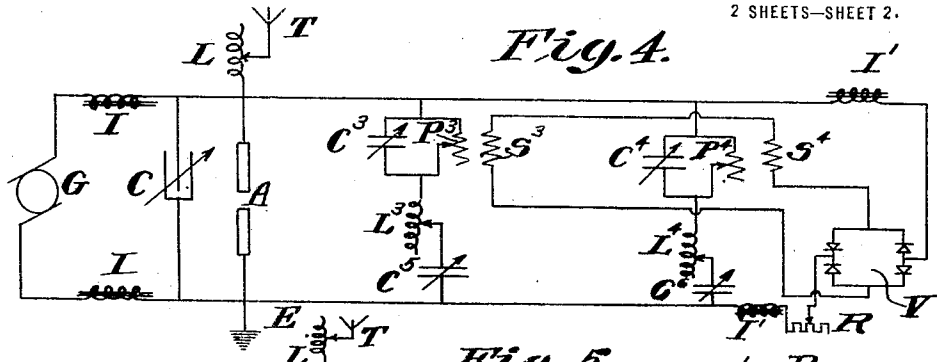


Fig. 5.

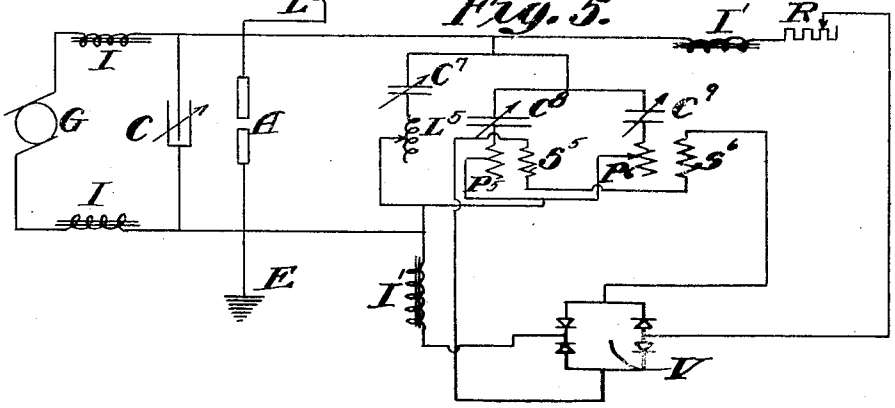
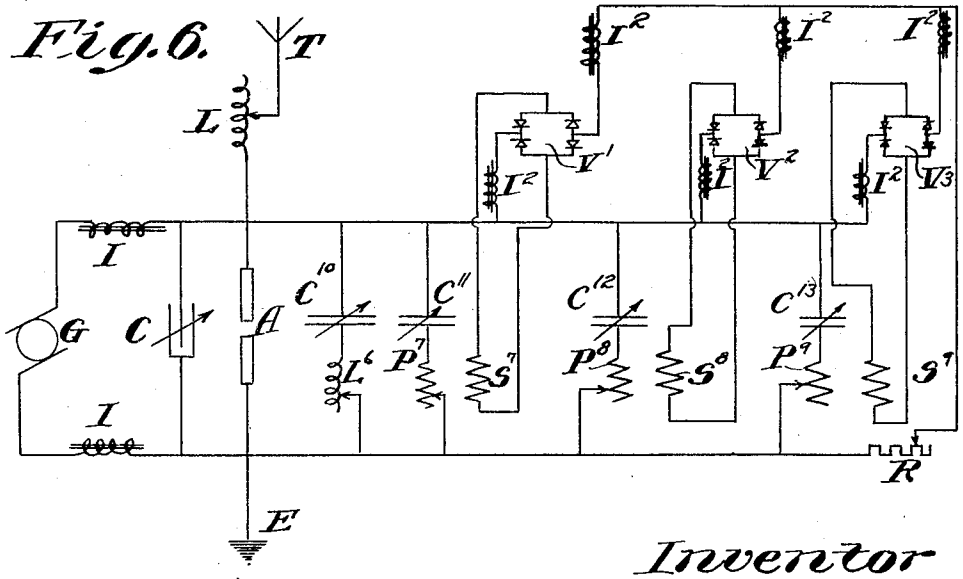


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC-WAVE-TRANSMITTING SYSTEM.

1,369,281. Specification of Letters Patent. Patented Feb. 22, 1921.

Application filed November 4, 1918, Serial No. 261,008. Renewed January 19, 1921. Serial No. 438,522.

To all whom it may concern:

Be it known that I, OSCAR C. ROOS, a citizen of the United States, and a resident of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Electromagnetic-Wave-Transmitting Systems, of which the following is a specification.

My invention relates to electromagnetic-wave transmitting systems and more especially to systems which are energized by substantially continuous oscillations such as those developed by an oscillating arc circuit.

In systems of this type the oscillations developed in the antenna are, in general, multi-periodic and one of the objects of the present invention is to provide means for absorbing one or more of the higher harmonics of the fundamental of the antenna system so that the transmitted electromagnetic waves will have the frequency of such fundamental and will be substantially simple harmonic. Another object is to provide means for absorbing the fundamental or said fundamental and one or more of the harmonics thereof so that the transmitted electromagnetic waves will have a higher frequency than said fundamental and will be substantially simple harmonic. In general my object is to provide means whereby oscillations of the undesired or parasitic frequencies are absorbed and the remaining oscillations transmitted as electromagnetic waves. A further object is to provide means for rectifying the oscillations so absorbed and for impressing the resulting unidirectional current on the arc circuit.

Apparatus of the general type described herein is disclosed in my Patent No. 1,309,778, dated July 15, 1919, and the claims of the present case are directed to modifications thereof in the nature of simplifications and improvements.

Several illustrative embodiments of my invention are shown conventionally in the accompanying drawings but it will be understood that various modifications may be made both in the apparatus and the system of circuits without departing from the principle of my invention.

In the drawings—

Figure 1 is a diagram of an electromagnetic wave transmitting system involving my invention in its simplest form wherein the energy of one harmonic of the antenna fundamental or of said fundamental itself is absorbed by a circuit conductively connected to the antenna. Fig. 2 is a similar diagram of a modification. Fig. 3 is a diagram of a further modification. Fig. 4 is a diagram of a transmitting system provided with a circuit for absorbing the energy of two frequencies which may be either two harmonics or else the fundamental and one harmonic. Fig. 5 is a diagram of another arrangement whereby the energy of two frequencies is absorbed. Fig. 6 is a diagram of a transmitting system for absorbing the energy of three frequencies.

In each of the figures a transmitting antenna T connected to earth at E includes the arc electrodes A shunted by the condenser C and connected to the direct current generator G through choke coils I, I, the circuit A C, together with the antenna and its loading coil L, constituting an oscillating-arc circuit.

In Fig. 1 there is conductively connected to the antenna and preferably across the arc a highly selective circuit which includes the condenser C′ and inductance L′, said circuit being resonant to a parasitic or non-useful frequency so that it will absorb the energy of such frequency. The oscillations which it is desired to use will be blocked by the circuit C′ L′, which will have a very high impedance for the same.

As is well understood it is impossible to develop oscillations of relatively high frequencies by an oscillating-arc circuit. If, therefore, the circuit C′ L′ be attuned to the fundamental the radiated waves will be those resulting from one or more of the higher harmonics of the fundamental and will be much shorter than those corresponding to the fundamental. As hereinafter more fully explained means may be provided for absorbing the fundamental oscillation and as many of the higher harmonics as desired, so that the transmitted waves will not only have a higher frequency than the fundamental but will be substantially simple harmonic.

If desired a regenerative circuit may be employed whereby the energy of the oscillation which is absorbed by the resonant circuit may be rectified and the resulting unidirectional current employed for assisting the source G in feeding the arc. In the present instance the regenerative circuit is shown

as inductively connected with the resonant circuit C′ L′ by the transformer P S, the primary of which is serially connected with the resonant circuit and the secondary with the rectifier V, the latter being connected through the regulator R and choke coils I′, I′ to the arc.

It will be understood, however, that my system for purifying the oscillations developed in the antenna is not limited to systems in which an oscillating arc is employed.

In Fig. 2 the absorbing circuit includes the parallel-branch circuit one branch of which contains the condenser C^2 or an equivalent capacity and the other the inductance P′, which in the present instance is shown as the primary of a transformer, or an equivalent inductance, said parallel-branch circuit being serially connected with a tuning element shown in the present instance as the inductance L^2, such conductively connected circuit being attuned either to the fundamental or one of the harmonics thereof, *i. e.* to one of the non-useful or parasitic frequencies, and said parallel-branch circuit being attuned so as to have a maximum or high impedance at the frequency to be radiated so that oscillations of said frequency will be blocked thereby. The energy of the oscillations absorbed by the conductively connected circuit will be translated to the secondary S′ and both pulses thereof rectified by the device V, and the resulting unidirectional current delivered to the arc through the regulator R and the choke coils I′. In Fig. 3 the parallel-branch circuit includes the condenser C^2 and the inductance L^2, and is serially connected with a tuning element shown in the present instance as the primary P^2 of a transformer the secondary S^2 of which is connected to the rectifier V. A storage battery R′ is included in the regenerative circuit and performs the same function as the regulator R above referred to in connection with Figs. 1 and 2.

In general the parallel-branch circuit will have a capacity reactance for oscillations of the frequency which it is desired to absorb as these are usually of higher frequency than the oscillation to be radiated, so that the tuning element L^2 or P^2 as the case may be will in general have an inductance reactance and for simplicity may be an inductance itself.

Extensions of the systems shown in their simplest forms in Figs. 1, 2, and 3 are represented in Figs. 4, 5, and 6.

In Fig. 4 the parallel-branch circuit C^3 P^3 is serially connected with a series resonant circuit L^3 C^5, and the parallel-branch circuit C^4 P^4 is serially connected with the series resonant circuit L^4 C^6. The parallel-branch circuits are each attuned to the frequency of the useful oscillation or the oscillation to be radiated, which oscillation may either be the fundamental or a harmonic thereof, and each circuit C^3 P^3 L^3 C^5 and C^4 P^4 L^4 C^6 is attuned so as to have a low impedance at the frequencies, respectively, of two of the parasitic oscillations which are to be absorbed. Thus if one of the circuits is attuned to the fundamental and the other to the first harmonic thereof the radiated wave will have a higher frequency than the first harmonic and will be more nearly sinusoidal than if only one such circuit were employed. As will be obvious I may use as many such circuits as may be desired for the purpose of rendering the transmitted wave as nearly simple harmonic as possible. In view of what has been said in connection with Fig. 1 it will be apparent that the parallel-branch circuits C^3 P^3 and C^4 P^4 may be omitted in cases where the series resonant circuits L^3 C^5 and L^4 C^6 are made highly selective.

The energy of the absorbed oscillations is translated to the secondaries S^3 S^4 which are connected in series with each other and with the rectifier V, and the resulting unidirectional current is conveyed to the arc by the leads which include the choke coils I′ and regulator R.

The preferred form of my invention is shown in Fig. 5. In Fig. 4 the position of the parallel-branch circuits is such that separate circuits each having maximum or high impedance at the useful frequencies and minimum or low impedance at the parasitic or undesired frequencies are connected across the arc. The same result may be obtained more simply by arranging the circuits in the manner shown in Fig. 5. The circuit C^8 P^5 is attuned to one parasitic frequency and the circuit C^9 P^6 to another, and they are connected in series with each other and in shunt to the arc. The circuit C^7 L^5 is tuned so that the combined branch reactances of the circuits C^8 P^5 and C^9 P^6 are equal and opposite in phase to its own reactance at the useful frequency, thereby causing the combined parallel-branch reactance of the circuits C^7 L^5 and the circuits C^8 P^5, C^9 P^6 to be a maximum or at least very high at the desired frequency thereby blocking the latter in the same way that such useful or desired frequency is blocked in the systems shown in Figs. 2, 3 and 4.

By way of specific example C^8 P^5 may be attuned to the first harmonic of the antenna fundamental, C^9 P^6 to the second harmonic and C^7 L^5 to a frequency lower than said fundamental. In such case at the frequency of the fundamental the circuits C^8 P^5 and C^9 P^6 will each have a capacity reactance and the circuit C^7 L^5 will have an inductance reactance. By rendering these two reactances equal an equivalent parallel-branch circuit is formed, the "condenser" branch

being formed by the circuits C^8 P^5 and C^9 P^6 which as above stated have capacity reactances at the frequency of the fundamental, and the "inductance" branch being formed by the circuit C^7 L^5 which at the fundamental frequency has an inductance reactance. Thus there is in effect connected across the arc a circuit which is anti-resonant at the frequency of the fundamental and resonant to two harmonics thereof.

It will be understood of course that the arrangement shown in Fig. 5 may be adjusted to absorb the fundamental and one of the harmonics thereof as well as two harmonics.

The energy of the absorbed oscillation is conveyed to the rectifier V by the serially connected secondaries S^5 S^6.

In Fig. 6 which is an extension of the arrangement shown in Fig. 5 three series resonant circuits C^{11} P^7, C^{12} P^8, C^{13} P^9 are connected across the arc and each is attuned to one of the non-useful frequencies. In shunt to the arc and to the series resonant circuits is a circuit C^{10} L^6 the function of which is the same as that of the circuit C^7 L^5 of Fig. 5. In this instance I have shown three rectifiers V' V^2 V^3 connected respectively with the secondaries S^7 S^8 S^9, and said rectifiers are connected to the arc terminals through leads which include the choke coils I^2. Obviously as many such series resonant circuits may be used as desired.

In Figs. 4, 5 and 6 the circuit which is conductively connected across the arc will have a maximum or high impedance at the frequency of the fundamental of the antenna system or at the frequency of the harmonic to be radiated, and a low or substantially minimum impedance at each of the frequencies of the oscillations which are not intended to be radiated.

By the term "oscillating-arc circuit" as used herein I desire to be understood as meaning a circuit which includes a condenser and arc-electrodes or other device or devices so arranged that when said circuit is energized by direct current substantially continuous oscillations are produced.

Having described illustrative embodiments of my invention without however limiting the same thereto what I claim and desire to secure by Letters Patent is:

1. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit associated with the antenna and including means for attuning said circuit so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental.

2. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit conductively connected to the antenna and including means for attuning said circuit so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental.

3. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which contains a capacity and the other an inductance, each of said parallel-branch circuits being attuned to the frequency of the oscillation that is to be radiated and a tuning element in series with each of said parallel-branch circuits.

4. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, a circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which acts as an equivalent capacity and the other as an equivalent inductance, each of said parallel-branch circuits being attuned to the frequency of the oscillation that is to be radiated and a tuning element in series with each of said parallel-branch circuits.

5. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, a circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which acts as an equivalent capacity and the other as an equivalent inductance, and a tuning element in series with each of said parallel-branch circuits, the first mentioned circuit being adjusted to have a maximum impedance at the frequency of the fundamental of said antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental.

6. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which contains a capacity and the other an inductance, each of said parallel-branch circuits being attuned to the frequency of the oscillation that is to be radiated and a series resonant circuit serially connected with each of said parallel-branch circuits.

7. An electromagnetic-wave transmitting system comprising in combination an an-

tenna system, means for creating electrical oscillations therein, a circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, each of said parallel-branch circuits being attuned to the frequency of the oscillation that is to be radiated, and a series resonant circuit serially connected with each of said parallel-branch circuits.

8. An electromagnetic-wave transmitting system, comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned to one of the harmonics of the fundamental thereof, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

9. An electromagnetic-wave transmitting system, comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a minimum impedance at the frequency of one of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

10. An electromagnetic-wave transmitting system, comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned to one of the harmonics of the fundamental thereof, means associated with the last mentioned circuit for rectifying both the positive and the negative pulses of the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

11. An electromagnetic-wave transmitting system, comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a minimum impedance at the frequency of one of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying both the positive and the negative pulses of the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

12. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit associated with the antenna and attuned so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

13. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating arc-circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a maximum impedance at the frequency of the fundamental of said antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

14. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a second circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which contains a capacity and the other an inductance, a tuning element in series with each of said parallel-branch circuits, means associated with said second circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

15. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a second circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which acts as an equivalent capacity and the other as an equivalent inductance, a tuning element in series with each of said parallel-branch circuits, means associated with said second circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

16. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations

therein, a second circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which acts as an equivalent capacity and the other as an equivalent inductance, a tuning element in series with each of said parallel-branch circuits, said second circuit being adjusted to have a maximum impedance at the frequency of the fundamental of the antenna system and a substantially minimum impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with said second circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

17. An electromagnetic-wave transmitting system, comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, and a parallel-branch circuit, one branch of which includes a capacity and the other an inductance, serially connected with said circuit, said parallel-branch circuit being attuned to the frequency of the oscillation that is to be radiated.

18. An electromagnetic-wave transmitting system, comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, and a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, serially connected with said circuit, said parallel-branch circuit being so attuned as to have a maximum impedance at the frequency of the oscillation that is to be radiated.

19. An electromagnetic-wave transmitting system, comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, and a parallel-branch circuit, one branch of which includes a capacity and the other an inductance, serially connected with said circuit, said parallel-branch circuit being so attuned as to have a maximum impedance at the frequency of the oscillation that is to be radiated.

20. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, and a circuit associated with the antenna and including means for attuning said circuit so as to have a maximum impedance at the frequency of the oscillation to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

21. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, and a circuit conductively connected to the antenna and including means for attuning said circuit so as to have a maximum impedance at the frequency of the oscillation to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

22. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit associated with the antenna and including a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, the first mentioned circuit including means for adjusting said circuit so as to have a maximum impedance at the frequency of the oscillation to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

23. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

24. An electromagnetic-wave transmitting system, comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a maximum impedance at the frequency of the oscillation that is to be radiated and a minimum impedance at the frequency of one of the oscillations that is not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

25. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit associated with the antenna and attuned so as to have a maximum impedance at the frequency of the oscilla-

tion to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated, means associated with the last-mentioned circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

26. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a maximum impedance at the frequency of the oscillation to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

27. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a second circuit associated with the antenna and including a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, said second circuit being adjusted to have a maximum impedance at the frequency of the oscillation to be radiated and a substantially minimum impedance at each of the frequencies of a plurality of oscillations that are not to be radiated, means associated with said second circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

28. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a plurality of series resonant circuits connected in multiple with said means and each attuned to the frequency of one of the oscillations that is not to be radiated, and another series resonant circuit also connected in multiple with said means but attuned to a frequency different from those to which the first mentioned series resonant circuits are attuned, the reactance of the last named series resonant circuit for the frequency of the oscillations that are to be radiated being equal and opposite in phase to the combined branch reactances of the first mentioned series resonant circuits.

29. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned to one of the harmonics of the fundamental thereof, and a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, serially connected with said circuit, said parallel-branch circuit being so attuned as to have a high impedance at the fundamental of said antenna system.

30. An electromagnetic-wave transmitting system comprising in combination an antenna system having a definite fundamental frequency, an oscillating-arc circuit arranged for creating therein electrical oscillations of said frequency, a circuit conductively connected to the antenna and attuned to one of the multiples of said frequency, and a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, serially connected with the last mentioned circuit, said parallel-branch circuit being attuned so as to have a high impedance at the fundamental of the antenna system.

31. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit associated with the antenna, and including means for attuning said circuit so as to have a high impedance at the frequency of the fundamental of said antenna system and a low impedance at each of the frequencies of a plurality of the harmonics of said fundamental.

32. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating electrical oscillations therein, and a circuit conductively connected to the antenna and including means for attuning said circuit so as to have a high impedance at the frequency of the fundamental of said antenna system and a low impedance at each of the frequencies of a plurality of the harmonics of said fundamental.

33. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a high impedance at the frequency of the fundamental of said antenna system and a low impedance at the frequency of one of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

34. An electromagnetic-wave transmitting system comprising in combination an antenna system an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit associated with the antenna and attuned so as to have a high impedance

at the frequency of the fundamental of said antenna system and a low impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

35. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a high impedance at the frequency of the fundamental of said antenna system and a low impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

36. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a second circuit associated with the antenna and including a plurality of parallel-branch circuits, one branch of each of which acts as an equivalent capacity and the other as an equivalent inductance, a tuning element in series with each of said parallel-branch circuits, said second circuit being adjusted to have a high impedance at the frequency of the fundamental of the antenna system and a low impedance at each of the frequencies of a plurality of the harmonics of said fundamental, means associated with said second circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

37. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, and a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, serially connected with said circuit, said parallel-branch circuit being so attuned as to have a high impedance at the frequency of the oscillation that is to be radiated.

38. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit conductively connected to the antenna and attuned to the frequency of one of the oscillations that is not to be radiated, and a parallel-branch circuit, one branch of which includes a capacity and the other an inductance, serially connected with said circuit, said parallel-branch circuit being so attuned as to have a high impedance at the frequency of the oscillation that is to be radiated.

39. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, and a circuit associated with the antenna and including means for attuning said circuit so as to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

40. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, and a circuit conductively connected to the antenna and including means for attuning said circuit so as to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

41. An electromagnetic-wave transmitting system comprising in combination an antenna system, means for creating multiperiodic electrical oscillations therein, a circuit associated with the antenna and including a parallel-branch circuit one branch of which acts as an equivalent capacity and the other as an equivalent inductance, the first mentioned circuit including means for adjusting said circuit so as to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations that are not to be radiated.

42. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a high impedance at the frequency of the oscillation that is to be radiated and a low impedance at the frequency of one of the oscillations that is not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

43. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit associated with the antenna and attuned so as to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations

that are not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein and means for impressing the resulting unidirectional current on the arc circuit.

44. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a circuit conductively connected to the antenna and attuned so as to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations that are not to be radiated, means associated with the last mentioned circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

45. An electromagnetic-wave transmitting system comprising in combination an antenna system, an oscillating-arc circuit arranged for creating electrical oscillations therein, a second circuit associated with the antenna and including a parallel-branch circuit, one branch of which acts as an equivalent capacity and the other as an equivalent inductance, said second circuit being adjusted to have a high impedance at the frequency of the oscillation to be radiated and a low impedance at each of the frequencies of a plurality of oscillations that are not to be radiated, means associated with said second circuit for rectifying the oscillations absorbed therein, and means for impressing the resulting unidirectional current on the arc circuit.

In testimony whereof, I have hereunto subscribed my name this 2nd day of October, 1918.

OSCAR C. ROOS.