June 17, 1941. E. L. BROWN 2,245,645

RADIO SIGNALING SYSTEM

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FIG. 1

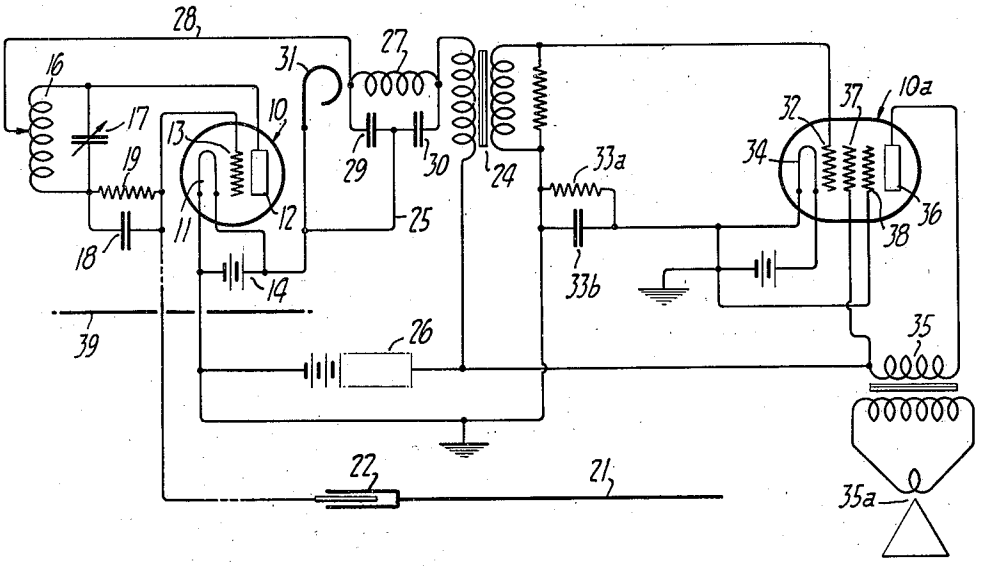
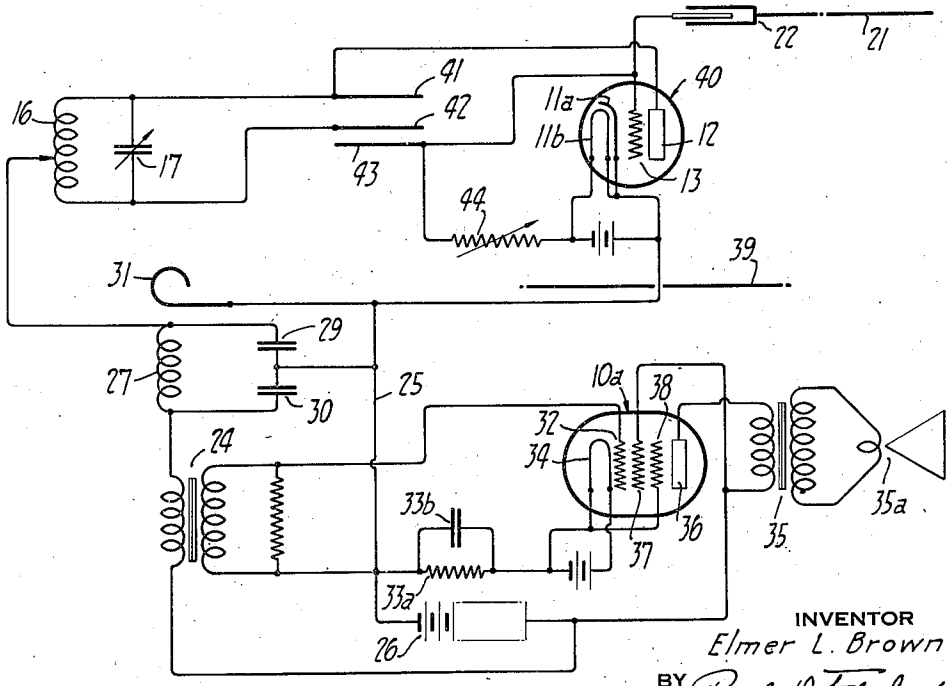


FIG. 2



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FIG_1a_

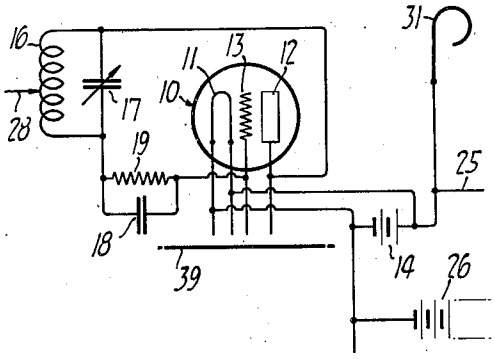


FIG_1c_

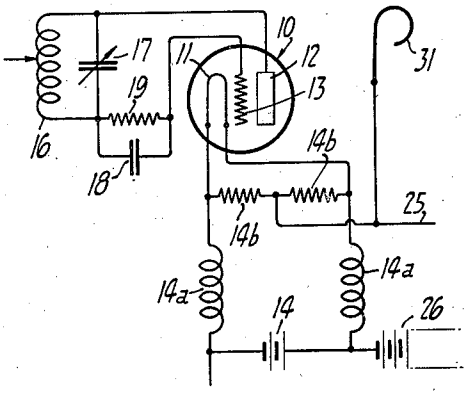
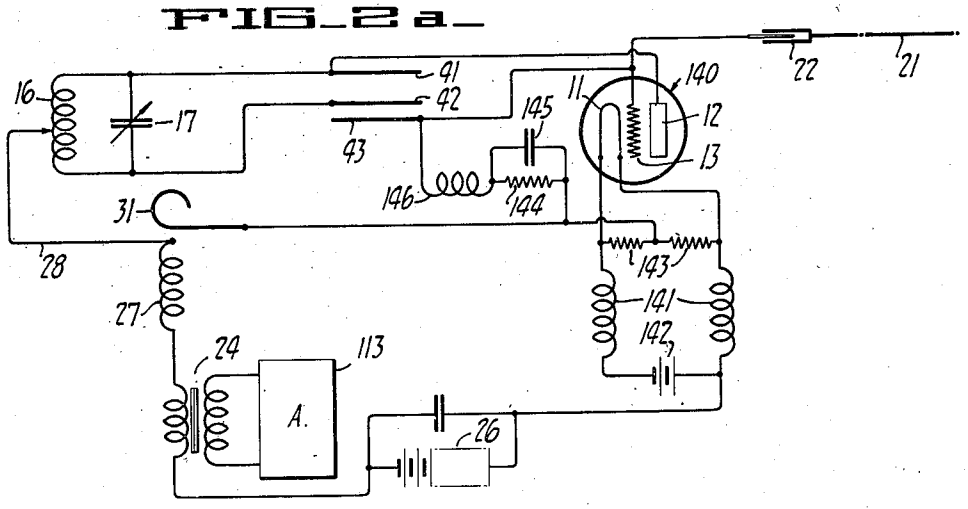


FIG_2a_



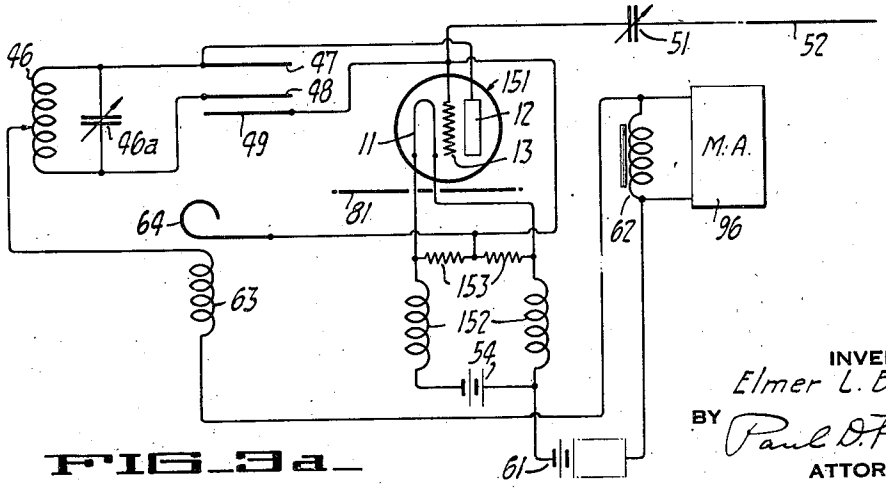


FIG_3a_

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FIG. 1b

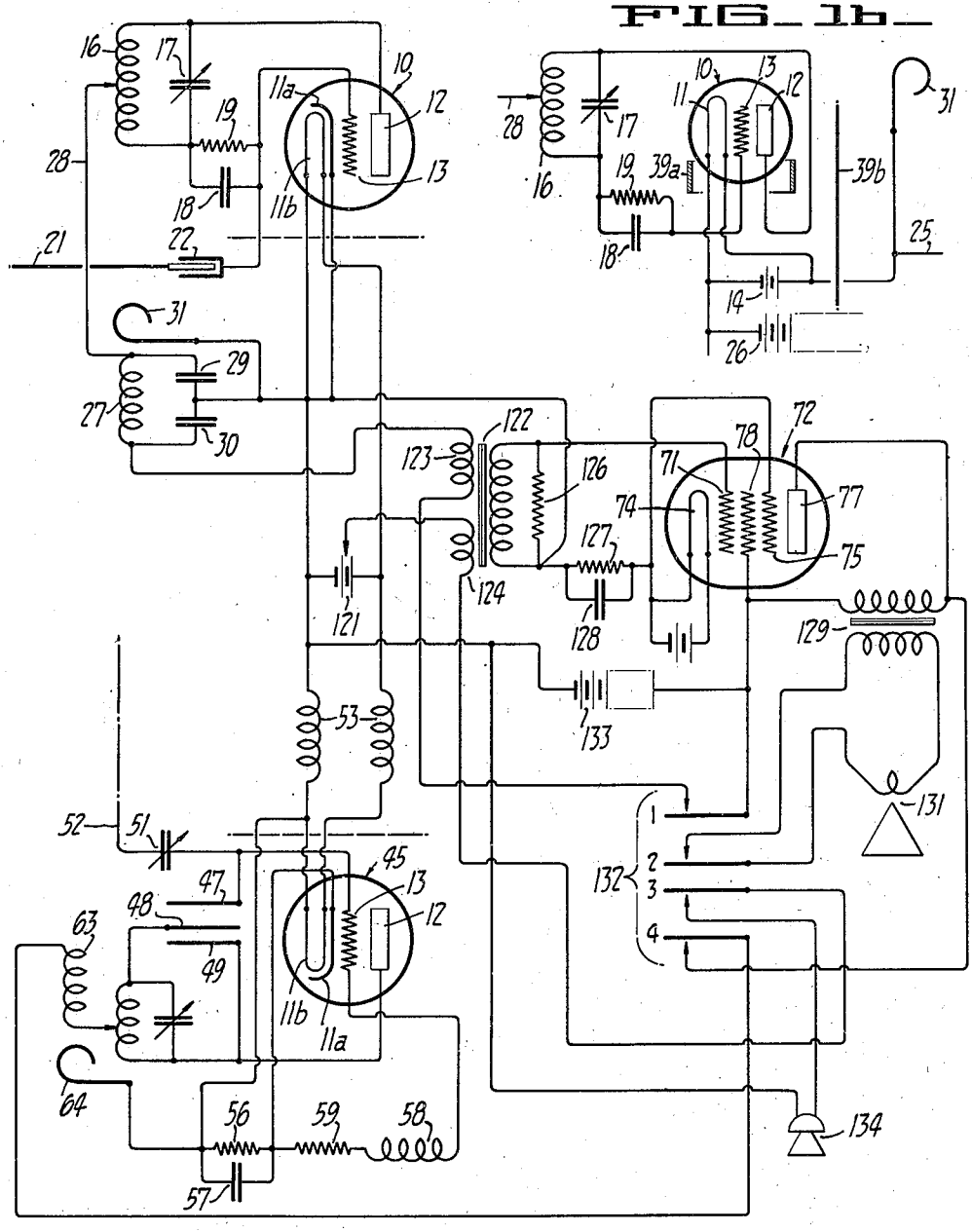


FIG. 9

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FIG. 3.

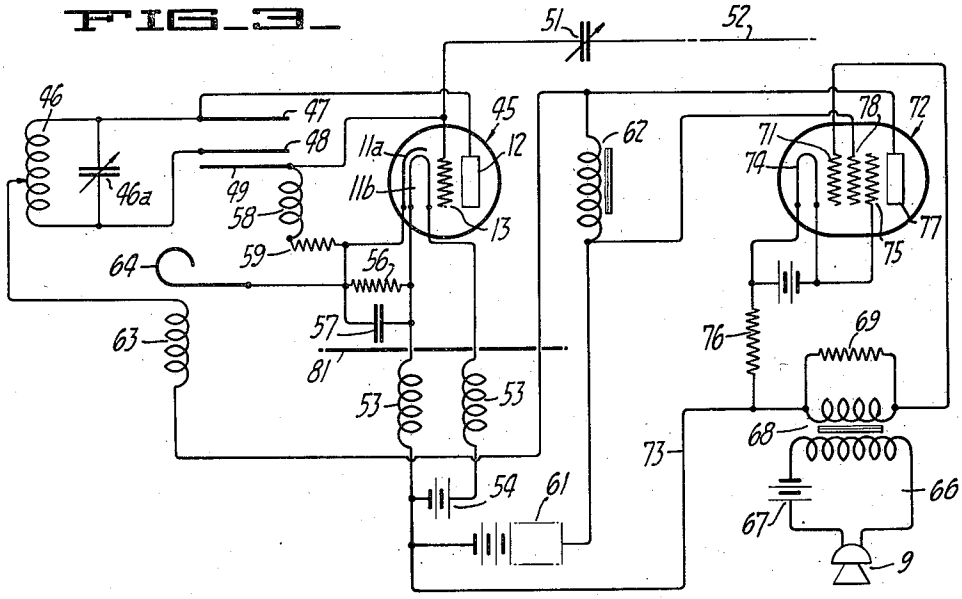


FIG. 4.

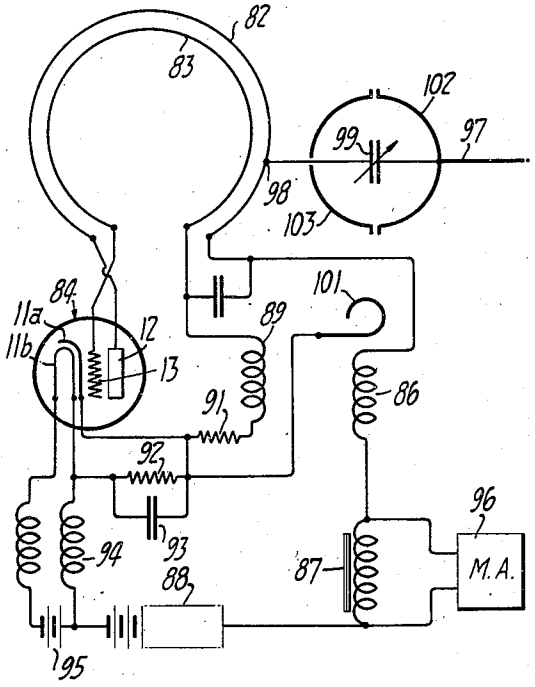
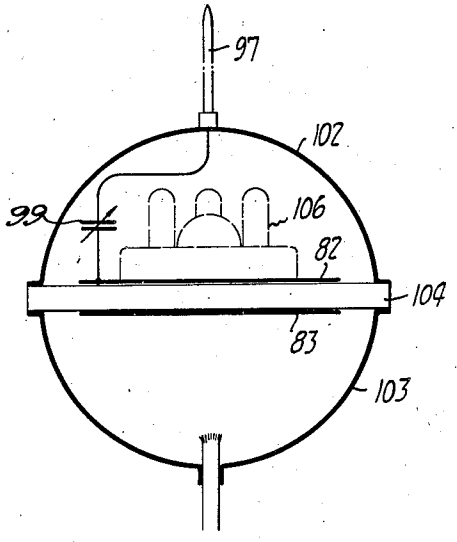


FIG. 5.



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FIG. 6.

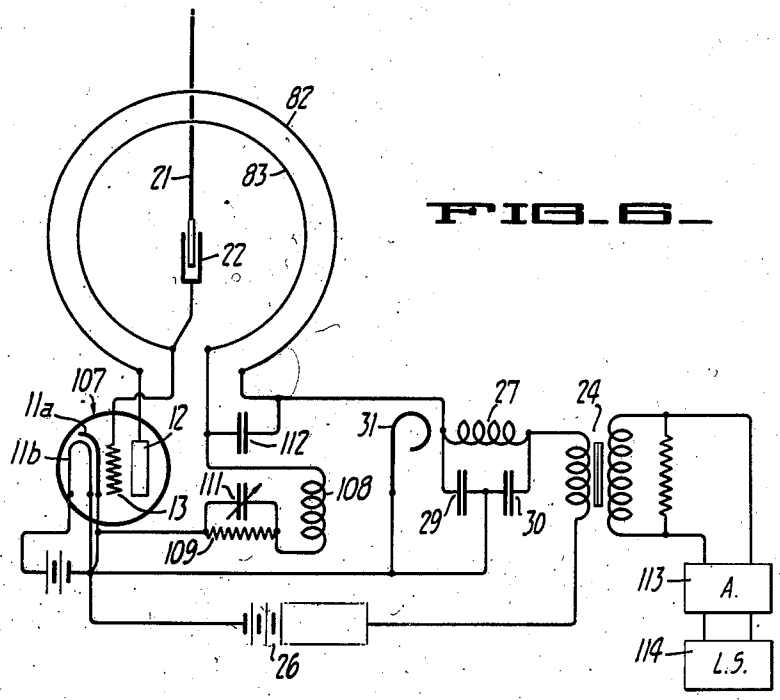


FIG. 7.

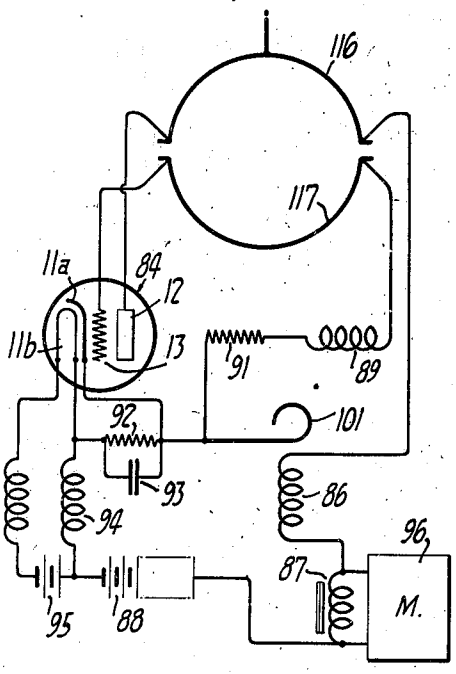
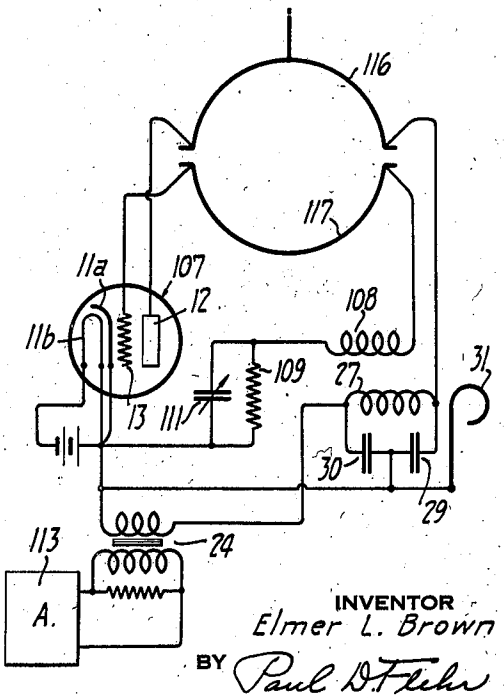


FIG. 8.



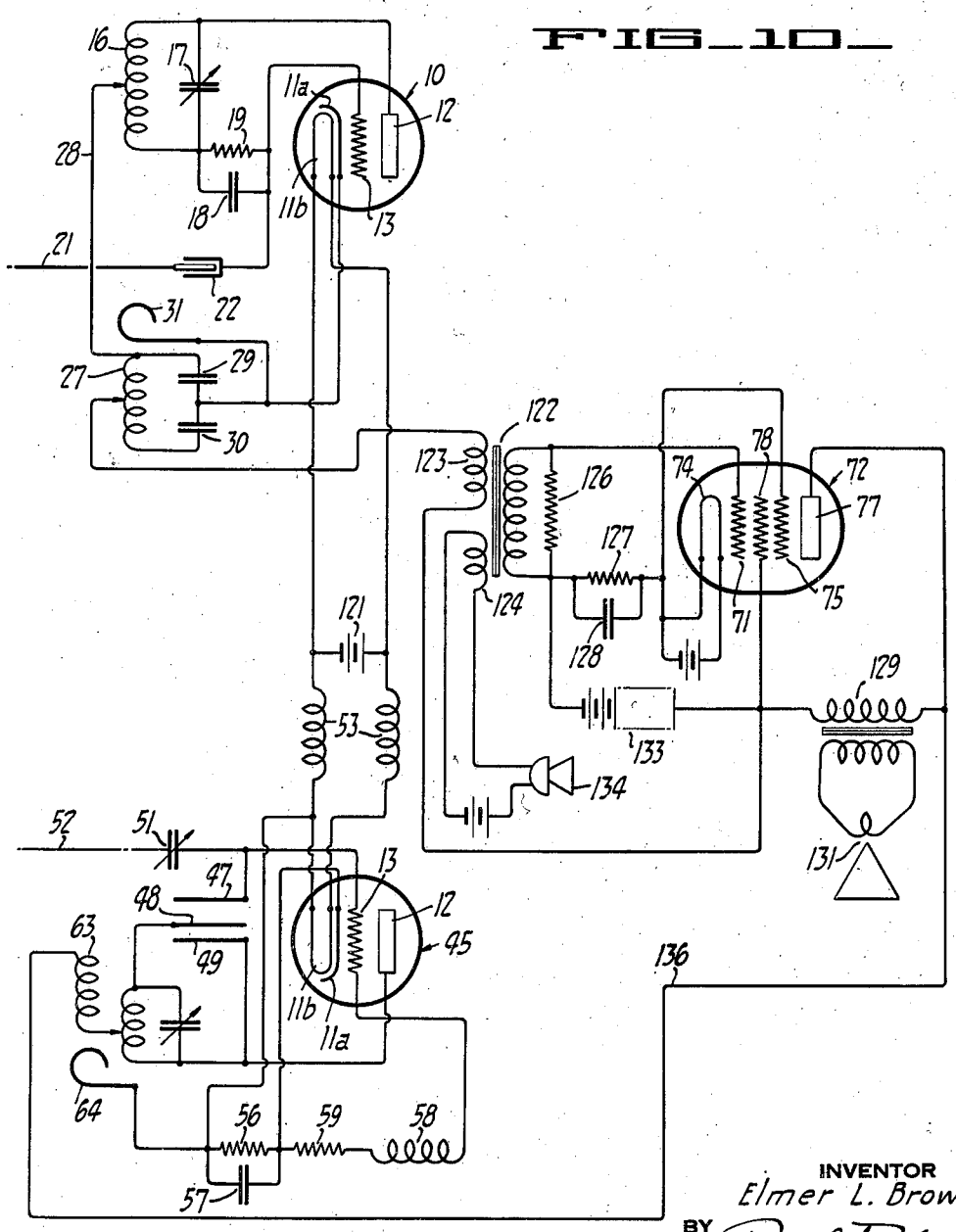
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FIG. 10



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Patented June 17, 1941 2,245,645

UNITED STATES PATENT OFFICE

2,245,645

RADIO SIGNALING SYSTEM

Elmer L. Brown, San Francisco, Calif., assignor to Joseph B. Smith, San Francisco, Calif., as trustee

Application April 13, 1940, Serial No. 329,479

10 Claims. (Cl. 250—20)

This invention relates generally to radio signaling systems making use of ultra high frequency radio energy, as for example energy of the order of from 100 to 400 megacycles. Features of the invention are applicable to both receiving and transmitting equipment.

It is an object of the invention to provide apparatus of the above character capable of increasing the effective distance over which one may successfully communicate with a given minimum amount of available power. A further object of the invention is to provide radio equipment capable of manufacture in compact form so as to be readily portable together with the required power supply.

Another object of the invention is to provide radio means capable of stable operation at ultra high frequencies with a minimum amount of interference and disturbing background noises, and without serious fading of a character such as is frequently characteristic of short wave radio equipment.

Another object of the invention is to provide a novel short wave receiver which is capable of hypersensitivity far beyond that made possible by the use of conventional super-regeneration, and which is also stable and relatively free of interference and disturbing background noises.

Another object of the invention is to provide a novel form of oscillator for use in conjunction with ultra high frequency radio transmitting equipment, and characterized particularly by its stability of frequency and by its ability to be assembled in compact form for portable use.

Additional objects and features of the invention will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawings.

Referring to the drawings—

Figure 1 shows a radio receiving circuit incorporating the present invention,

Figures 1*a*, 1*b* and 1*c* are circuit diagrams illustrating possible modifications of the circuit shown in Figure 1;

Figure 2 shows a modified radio receiving circuit;

Figure 2*a* is a circuit diagram illustrating a possible modification of the circuit shown in Figure 2;

Figure 3 shows a short wave radio transmitter circuit incorporating the invention;

Figure 3*a* is a circuit diagram illustrating a possible modification to the transmitter illustrated in Figure 3;

Figure 4 is a circuit diagram showing a modified form of a short wave transmitter, while Figure 5 is a cross sectional view, in diagrammatic form, illustrating how the transmitter of Figure 4 can be incorporated into a structural assembly;

Figure 6 shows a modified form of radio receiving circuit incorporating the invention;

Figures 7 and 8 show radio transmitter and receiver circuits respectively incorporating the invention and making use particularly of conductive hemispheres forming a part of the inductance elements;

Figure 9 is a circuit diagram showing a radio receiver and transmitter interconnected by switching means for two way communication; and Figure 10 is a circuit diagram showing a radio transmitter and receiver interconnected for two way radio communication upon different frequencies, without a change-over switch.

The circuit illustrated in Figure 1 is for the reception of ultra high frequency signal energy and is suitable for incorporation in a small portable telephone receiver. The circuit includes a vacuum tube detector **10**, or electron relay, having the conventional cathode, plate and control elements **11**, **12** and **13**. This tube may be one available on the open market, such as type 6-C-5 made by Radio Corporation of America. The cathode is shown connected to the A battery **14**. A tuned circuit connects across the plate and control elements **12** and **13**, and this circuit includes the inductance **16** shunted by the variable condenser **17**, whereby the inductance is sharply tuned to the frequency of the signal energy. One terminal of inductance **16** connects directly with plate **12**, while the other terminal connects with the grid or control element **13** through the grid condenser **18** and grid leak **19**.

The antenna **21** can be a straight rod of conductive material, having a length corresponding generally to one-quarter wave length. One end of this antenna is reactively coupled to the tuned circuit just described. Preferably this coupling is through a relatively small variable condenser **22**, which in turn connects directly to the grid control element **13**. As will be presently explained, the receiver is critical to the adjustment of the condenser **22**.

The detector tube **10** is coupled to an amplifier, including the vacuum tube **10***a*, through the audio frequency transformer **24**. The primary of transformer **24** has one terminal connected to the positive side of B battery **26**, and the negative side of this battery is connected to the cathode

11. The other terminal of the primary of transformer 24 is connected to one side of an inductance 27, the other terminal of which is connected by a conductor 28 with the mid point of inductance 16. Inductance 27 is shunted by a pair of serially connected condensers 29 and 30. Condenser 29 is relatively large in capacitance compared to condenser 30, as for example a capacitance of 0.006 m. m. f. in contrast with 0.0001 m. m. f. capacitance for condenser 30. These capacitance values are suitable for a receiver operating over a range of from 165 to 225 megacycles, with the inductance 27 consisting of from 25 to 30 turns of No. 24 wire, wrapped upon a cylindrical form one-quarter inch in diameter. The connection between condensers 29 and 30 is connected by conductor 25 to the cathode 11. The tuned circuit formed by inductance 27 together with condensers 29 and 30 is in resonance with a supersonic frequency substantially less than the ultra high frequency of the signal energy to be received, as for example a frequency of the order of 11 megacycles. The smaller condenser 30 acts mainly as a tuning condenser, while condenser 29 because of its higher capacitance acts as a by-pass.

Closely coupled to that end of inductance 27 which is connected to tuned inductance 16, there is an open ended loop 31, formed for example by a three-quarter turn of wire disposed relatively close to the coil forming inductance 27. One end of this loop connects to the cathode 11.

The amplifying means connected to the secondary of transformer 24 may be more or less conventional in character. As illustrated, the vacuum tube 10*a* is a pentode, having its grid or control element 32 connected to one side of the secondary of transformer 24. The other side of the transformer secondary connects through the grid leak 33*a* and grid condenser 33*b*, to the cathode 34. The amplifier output transformer 35 has its primary connected to the plate 36, and the tube element 37. The tube element 38 or screen is connected to the cathode 34. The positive side of B battery 26 also connects in series with the primary of transformer 35 and plate 36. The secondary of the transformer 35 is shown operating the loud speaker 35*a*.

The circuits associated with the detector tube 10 should be properly shielded as is well known to those skilled in the art. In addition to, or as a part of such shielding, I have found it desirable to use a conductive plate 39 disposed equidistant from each of the external terminals of the vacuum tube 10, or from the terminals of the socket in which the tube is mounted. The object of such a plate is to afford small but equal supplemental capacitance values between the relatively neutral point of potential represented by the plate and each terminal of the elements of the tube. Such small capacitance values appear to be beneficial in operation of the receiver as will be presently explained, and they supplement the internal and direct capacitance between the cathode, plate and control elements. For a receiver as described above, it is practical to locate the plate 39 about one-quarter inch from the socket terminals. Figure 1*a* illustrates the arrangement diagrammatically. Plate 39 need not be grounded. Figure 1*b* shows an arrangement which can be used in place of Figure 1*a*, but with results not deemed to be so effective. In this case, tube 10 is provided with a metal base ring 39*a* which surrounds but is capacitatively spaced from the inner parts of the tube elements. A further conductive plate 39*b* is located adjacent the tube and may be disconnected entirely or connected to one side of the cathode. Plate 39*b* represents a point of relatively neutral potential which is capacitatively associated with ring 39*a*, the value of the relation being adjustable by moving the position of the plate.

The receiver described above possesses several novel characteristics, including its ability to operate under conditions of hypersensitivity. Adjustment of the receiver to obtain the desired hypersensitivity is obtained by changing the value of the antenna coupling condenser 22. This condenser is relatively small, and for values previously stated by way of example, the condenser may be capable of continued variation from a maximum value of say 4 m. m. f. to a value of less than 1 m. m. f. When condenser 22 is of the order of say 2 m. m. f., the receiver is capable of super-regeneration, in that there is a regenerative action coupled with the generation of a supersonic quenching frequency corresponding to the frequency to which inductance 27 is tuned. Conventional super-regeneration is well known to those skilled in the art, and need not be described in detail. If one further reduces the capacitance of condenser 22, a value is reached at which the circuit clicks or "plops" from a condition of conventional super-regeneration, into what I have termed a condition of hypersensitivity in which it functions as a true negative resistance. During normal super-regeneration, the plate current for the detector tube 10 in a typical instance will be of the order of 2.5 milliamperes for a B battery potential of 90 volts, and in general the value of condenser 22 is a minor fraction (such as 10% of the value suitable for conventional super-regeneration.

For a condition of conventional super-regeneration, there is a noticeable hissing together with other disturbing and interfering background noises. When adjusted for a condition of hypersensitivity, such hisses and background noises disappear substantially completely, the tuning becomes sharper without being too critical, there is a noticeable increase in fidelity of reproduction when operated upon radio telephone signals, and incoming signals become noticeably louder. In addition, the receiver becomes extremely stable so that body capacitance and surrounding metallic objects have negligible effect upon sensitivity or frequency of operation. The sensitivity is so great that even with a fraction of a watt being transmitted from a remote radio telephone installation, signals can be heard clearly without distortion through large physical obstructions, through conductive material such as steel or salt water, and under normal conditions for distances of ten miles or more.

The loop 31 appears to play a material part in securing the desired sensitive operation with stability and suppression of background noises. I attribute this in part to an acceleration in the transit time for electrons in tube 10, which is obtained by energy exchange between loop 31 and inductance 27. This energy exchange is in the nature of positive voltage from the cathode to inductance 27 and the plate circuit. It will be noted that the reactive coupling obtained by the relationship between loop 31 and inductance 27 is mainly capacitative, but because capacitance is distributed the length of the loop, there is also some inductive coupling. Also in contrast with conventional regeneration, coupling 22 is so small

as to have negligible effect upon the frequency of operation.

A further characteristic of the above circuit is that the primary of the transformer **24** is not shunted by a condenser or resistance. In conventional super-regenerative receiving circuits of the type which generate a quenching frequency in the detector circuit, it is customary to provide the primary of the output transformer with a shunt condenser, whereby the primary of the transformer is tuned to the supersonic quenching frequencies. Although in the present instance the primary of the transformer **24** may have a natural period corresponding to a supersonic frequency, this resonant circuit is not completely excited to an extent sufficient to cause such a frequency to be generated, but instead the circuit formed by inductance **27** with condensers **29** and **30** is excited for generation of the desired supersonic frequency.

The capacitator plate **39**, or the alternative arrangement of Figure 1b, appears to materially contribute to proper results. According to my observations, the small supplemental capacitances afforded between the tube elements and plate **39** serve as a part of neutralizing means which in conjunction with the loop **31**, neutralize out inductive reactance of the tube elements and provide a minimum input impedance for the receiver. This in turn facilitates operation under the desired condition of hypersensitivity previously described, since the neutralizing action makes possible operation of the circuit with minimum energy dissipation and at maximum sensitivity.

Reference has been made to suitable values for inductance **27**, and condensers **29** and **30**. By way of example, the other elements of the circuit can have values as follows: Inductance **16** may consist of from 3 to 5 turns of No. 14 wire wound as a helix about a form $\frac{5}{16}$ inch in diameter. Condenser **17** can have a maximum value of 15 m. m. f. Condenser **18** and resistor **19** can have values of .0001 m. f. and 5 megohms respectively. Transformer **24** can have a primary impedance of 7500 ohms and a secondary impedance of 100,000 ohms.

Figure 1c shows a possible modification of Figure 1. Radio frequency chokes **14***a* are inserted between the cathode terminals and A battery **14**, and loop **31** connects between resistors **14***b*, which in turn are in series and connected across the cathode terminals. Resistors **14***b* can be of the order of 3500 ohms each.

The embodiment of Figure 2 is a receiver similar to that of Figure 1, except that the circuit which includes the tuned inductance **16** also includes certain capacitive elements, and the detector tube **40** makes use of a cathode **11***a*, together with a heater **11***b*. Thus, three conductive elements **41**, **42** and **43** are provided which for the frequency range of operation previously indicated may consist of metal discs about $\frac{5}{8}$ inch in diameter, with discs **41** and **42** spaced apart about $\frac{3}{16}$ of an inch by suitable insulation such as "Mycalex" and discs **42** and **43** spaced apart about 0.005 inch, with a dialectric such as mica. Disc **41** connects to that terminal of inductance **16** which is also connected to the plate **12**. Disc **42** connects to the other terminal of inductance **16**. Disc **43** connects to the grid or control element **13**, and also through the adjustable grid leak **44** to the cathode **11***a*.

The receiving circuit shown in Figure 2 is capable of operating in substantially the same manner as the circuit of Figure 1. However, the grid leak **44** requires adjustment for the proper operating point. For the values and for the range of frequencies previously specified, this will be in the neighborhood of from 50,000 to 100,000 ohms.

Figure 3 illustrates a radio telephone transmitting circuit which embodies certain features of the circuit shown in Figures 1 and 2. In this instance the vacuum tube **45** has its elements connected to circuits for generation of ultra high frequency which can be modulated by voice current, by talking into the microphone **9**. Inductance **46** is shunted by a condenser **46a**, and thereby tuned to the desired frequency of operation. Spaced plates **47**, **48** and **49** are provided, and for frequencies of the order of from 165 to 225 megacycles, these plates can be discs about $\frac{5}{8}$ inch in diameter, with discs **47** and **48** separated about one-quarter of an inch by suitable insulating material, and plates **48** and **49** separated about 0.005 to 0.010 inch by suitable insulation such as mica. Plates **47** and **48** connect across terminals of inductance **46**. Also, that side of the inductance to which plate **47** is connected is also connected to the plate **12**. Plate **49** is connected to the grid or control element **13**. The grid **13** is also connected through the small coupling condenser **51**, with the antenna **52**. This antenna may be a conductive rod having a length corresponding to substantially one-quarter wave.

The terminals of the heater **11***b* connect in series with the radio frequency chokes **53** to the terminals of the A battery **54**. Cathode **11***a* is also connected to one side of the heater **11***b*, through the resistor and condenser **56** and **57**. Disc **49** connects to one side of a radio frequency choke **58**, the other end of which connects through the resistor **59** with the cathode **11***a*. The B battery **61** has a negative terminal connected to the heater circuit, and its positive terminal is connected to the audio frequency choke **62**. The other side of choke **62** is connected in series with an inductance **63**, to the mid point of the tuned inductance **46**. Inductance **63** operates as a radio frequency choke, the same as choke **53**, and can be formed of 25 turns of No. 24 wire wound as a helix upon a one-quarter inch form. An open ended looped wire **64**, corresponding to the open ended loop **31** of Figures 1 and 2, is closely coupled to that end of inductance **63** which is connected to inductance **46**. One end of loop **64** is connected to the cathode **11***a*. The microphone **9** is in series with a microphone circuit **66**, which includes the battery **67** and the secondary of a transformer **68**. The secondary of this transformer is shown by-passed by resistor **69**, and has its one terminal connected to the grid or control element **71** of the amplifying pentode **72**, and its other side connected by conductor **73** to the negative side of B battery **61**. Cathode **74** of the pentode **72** is connected to the element **75**, and also through the resistor **76** to the negative side of B battery **61**. The terminals of audio frequency choke **62** are connected to the plate **77** and the element **78** of the pentode.

The circuit described above with reference to Figure 3 is capable of generating oscillations of the order of from 165 to 225 megacycles, and is relatively stable with respect to the frequency generated. The open ended loop **64** in this instance aids in attaining proper stability, and in addition makes possible additional output.

It is also desirable in connection with this oscillator to make use of a conductive plate **81** equi-distant from the terminals of the socket in

which the tube 45 is seated. As explained in connection with Figure 1, such a plate affords by-pass paths directly from the tube elements, and as in the case of the receiver it aids in conjunction with loop 64 in neutralizing the inductive reactance values of the tube elements. Also, in this instance use of plate 81 makes possible greatly increased energy transfer to the antenna. This is attributed to the fact that output impedance of the transmitter is decreased for the ultra high frequencies employed.

The oscillations being generated are modulated by speaking into the microphone 9, since the voice currents as amplified by the pentode 72 are impressed directly upon the inductance 46. Loop 64 serves to lend stability and also tends to prevent shifts in frequency, and to make for maximum output.

Figure 4 shows a further modified type of oscillator which makes use of single turn inductances of substantial diameter for determining the frequency of operation. Thus, there are two single turn loops 82 and 83 which in practice are made to the same diameter, and which are positioned in spaced parallel relationship. One terminal of the loop 82 connects to the plate 12 of vacuum tube 84, while the other terminal of this loop is connected in series with a radio frequency choke 86, the audio frequency choke 87, and the B battery 88. One terminal of the other loop 83 connects with grid 13, while the other terminal connects in series through the radio frequency choke 89, and the resistor 91 to the cathode 11*a*. Cathode 11*a* is also connected to one side of the heater 11*b*, through the resistor 92 and condenser 93. The terminals of heater 11*b* connect through radio frequency choke 94 to the A battery 95. One side of the A battery 95 connects with the negative side of B battery 88.

Modulating amplifier 96 is connected across the audio frequency choke 87. The antenna 97 is shown connected to a point 98 on the inductance 82, and through the variable coupling condenser 99. An open ended loop 101 is closely coupled with radio frequency choke 86, and is directly connected to the cathode 11*a*. This oscillation generator will also produce frequencies of the order of from 100 to 400 megacycles, with a high degree of stability.

In assembling a portable radio receiver, it has been found desirable to associate certain of the parts, principally the antenna and the loops 82 and 83, with a pair of hemispheres 102 and 103, made of conductive material like copper. A possible arrangement is shown diagrammatically in Figure 5. In this instance the peripheries or open faces of the two hemispheres are spaced apart by the disc 104 of insulating material. The center of hemisphere 102 conductively connects with the antenna rod 97. The two loops 82 and 83 are mounted upon opposite sides of the disc 104, within the hemispheres. If desired, additional parts of the receiver can be mounted within the hemispheres, with the exception of the power supply batteries, and parts of the modulating means. Such additional parts are outlined generally at 106. With hemispheres measuring about 3 inches in diameter, for range of frequencies of operation as indicated above, the hemispheres not only serve as a convenient and effective shielding, but in addition they afford reactive elements which have a flywheel effect in stabilizing the frequency of operation.

Single turn loops can also be used in conjunction with a receiver capable of hypersensitive operation, as previously described. Thus, referring to Figure 6, I have shown two loops 82 and 83, like those described with reference to Figure 4, but connected in a receiving circuit including the detector vacuum tube 107. One terminal of loop 82 connects with plate 12, while the other terminal is connected in series with the inductance 27, the primary of transformer 24, and B battery 26. Inductance 27 corresponds to inductance 27 of Figure 1 and is likewise shunted by condensers 29 and 30, to be resonant to the desired supersonic frequency. The open ended loop 31 is also closely coupled to inductance 27, as in Figure 1. One terminal of the loop 83 is connected to the grid 13, and is also connected through the small coupling condenser 22 with the antenna 21. The other terminal of loop 83 is connected through radio frequency choke 108, resistor and shunted condenser 109 and 111, to the cathode 11*a*. The same terminal of loop 83 is connected to the corresponding terminal of loop 82, through the condenser 112. The secondary of transformer 24 is shown diagrammatically connected to the audio frequency amplifier 113, which in turn is connected to the loud speaker 114.

The receiving circuit of Figure 6 operates in substantially the same manner as the circuits of Figures 1 and 2. For a given setting of the condenser 22, the circuits will operate in accordance with conventional super-regeneration. For a reduced value of condenser 22, the circuit passes abruptly into a state of hypersensitivity, with the virtual elimination of background noises.

Figure 7 illustrates a type of oscillation generator circuit which makes use of two hemispheres, but which eliminates use of single turn loops corresponding to loops 82 and 83 of Figures 4 and 5. Thus, although the circuit in this instance is substantially the same as in Figure 4, the two hemispheres 116 and 117 take the place of the loops 82 and 83. Diametrically opposite points on the periphery of hemisphere 116 are connected to the plate 12 and to the radio frequency choke 86 respectively. Diametrically opposite points on the periphery of the hemisphere 117 are connected to the grid 13 and the radio frequency choke 89. Thus, the two hemispheres become inductances which determine the frequency of operation, and these two inductances are coupled together because of the proximity between the two hemispheres.

An arrangement somewhat similar to Figure 7 can also be used for receiving purposes, and is illustrated in Figure 8. The numbering of the parts in this instance corresponds generally to Figure 6. The two hemispheres 116 and 117 in this instance take the place of the loops 82 and 83 of Figure 6, and are similarly connected in the circuit.

Figure 9 shows a radio transmitter and receiver arrangement for two way communication. The receiving circuit is similar to that described with reference to Figure 1, or the transmitting circuit is similar to that described with reference to Figure 3. The two cathode heaters 11*b* of the tubes 10 and 45 are shown supplied with current from the same A battery 121. The pentode 72 corresponds to the pentode 72 of Figure 3, but functions as a combined modulation current amplifier, and as an amplifier of the received signals. A special audio transformer 122 is coupled to the pentode 72, and is provided with two separate primary windings 123 and 124. The secondary of transformer 122 is shown shunted by the resistor 126, and has its one terminal connected to the

grid 71 of the pentode. The other terminal of the transformer secondary connects resistor 127 and shunt condenser 128 to the cathode 74 and pentode element 75.

Output transformer 129 has its primary connected to plate 77 and pentode element 78, and its secondary is connected to the voice coil of loud speaker 131. A manual change-over switch 132 is provided which has four sets of switch contacts 1, 2, 3 and 4. When the blades of the switch are all moved in one direction, namely upwardly as viewed in Figure 9, contacts 1 and 2 are closed, contacts 3 and 4 are opened and the system is in condition for sending. When all of the blades are moved downwardly, contacts 1 and 2 are opened, contacts 3 and 4 closed, and the system is in condition for receiving. Contacts 2 are connected in series with the circuit for the loud speaker 131, so that the loud speaker is open circuited when contacts 2 are opened. Contacts 1 are connected in series with one terminal of transformer primary 123, and the positive side of the B battery 133. Contacts 3 connect in series with one side of the microphone 134, and the plate 77 of pentode 72. Contacts 4 connect in series between the plate of pentode 72 and choke 63 of the transmitter. The other terminal of transformer primary 123 connects with the tuned inductance 27, which as previously described, determines the supersonic frequency for the receiver. The other terminal of the primary 124 is shown connected to an intermediate point of the A battery 121.

Assuming now that switch 132 is moved to sending position, the microphone is serially connected with the transformer primary 124, so that talking into this microphone causes voice currents to be set up in the secondary of transformer 122, and impressed upon the input of the pentode 72. Amplified voice currents in the output of pentode 72 are impressed through contacts 4 upon the circuit which includes the choke 63 of the oscillation generator. B battery potential is also applied to the oscillator through choke 63, by virtue of the connection through the primary of output transformer 129, the positive side of B battery 133. When the blades of switch 132 are moved in an opposite direction, the B battery supply to the oscillator is interrupted, because of opening of contacts 4, and the microphone circuit is also opened because of opening of contacts 3. The closing of contacts 1, however, connects the primary winding 123 of transformer 122 with the positive side of B battery 133, to energize the receiver, while closing of contacts 2 closes the output circuit of transformer 129, so that received signals are properly reproduced by the loud speaker.

Figure 10 shows a circuit diagram for receiver and transmitter substantially as shown in Figure 9, but without using a change-over switch. In this instance, the transmitter and receiver must operate upon two distinct frequencies. In this instance the change-over switch 132 of Figure 9 is omitted, and the primary 124 of transformer 122 is directly connected to the microphone 134. Conductor 136 directly connects the plate of the pentode 72 to the radio frequency choke 63 of the oscillator circuit, thus directly applying the amplified audio frequency output of the pentode to the transmitter. Received signals are also amplified by the pentode 72 and applied to the loud speaker 131. Assuming the use of two distinct frequencies, as for example 125 megacycles for the transmitter, and 175 megacycles for the receiver, both transmitter and receiver can remain in constant operation during two way communication.

Figure 2*a* illustrates a possible modification of the receiver shown in Figure 2. Tube 140, however, is a triode, and the terminals of cathode 11 connect through radio frequency chokes 141 to the A battery 142. Resistors 143, having values of the order of 3500 ohms each are connected in series across the cathode terminals, and the mid point of connection between the resistors is connected to loop 31. Disc 43 at its mid point connects with plate 43 through the grid leak and grid condenser 144, 145, and the radio frequency choke 146.

Figure 3*a* illustrates a further possible modification of Figure 3. In this instance tube 151 is a triode with its terminals connected through radio frequency chokes 152 to the A battery 54. Resistors 153, of suitable values, such as 1,000 ohms each, connect across the terminals of cathode 11, and the mid point between the resistors is connected directly to disc 49 and loop 64. Thus, resistors 153 not only establish connection with the cathode, but in addition make it possible to dispense with resistor and condenser 56 and 57, and resistor 59 and choke 58.

I claim:

1. In an electrical vacuum tube network for ultra high frequency signal energy, a vacuum tube having cathode, plate and control elements, a tuned inductance having its terminals operatively connected to the control and plate elements, a circuit including a source of B battery potential operatively connected to the inductance and to the cathode, a second inductance in series with the last named circuit between the electrical mid point of the tuned inductance and the source of B battery potential, and an open ended looped conductor coupled with said last named inductance, one end of the looped conductor being connected to the cathode.

2. In an electrical vacuum tube network for ultra high frequency signal energy, a vacuum tube having cathode, plate and control elements, a tuned inductance having its terminals operatively connected to the control and plate elements, a circuit including a source of B battery potential operatively connected to the inductance and to the cathode, a second inductance in series with the last named circuit between the electrical mid point of the tuned inductance and the source of B battery potential, and an open ended looped conductor coupled with said last named inductance, one end of the looped conductor being connected to the cathode, and means providing supplemental capacitances between the elements and a common point of relatively neutral potential.

3. In a radio receiving system for ultra high frequency signal energy, a vacuum tube detector including cathode, plate, and control elements, a circuit including a tuned inductance resonant to the frequency to be received, said circuit being connected to elements of the vacuum tube, another circuit including the primary of an audio frequency transformer and a tuned inductance resonant to a supersonic frequency substantially less than the frequency of the signal energy, both said circuits being connected to the elements of the detector tube with positive feed back of oscillatory energy to effect regenerative operation and with simultaneous generation of a supersonic quenching frequency, an antenna, and means for adjusting the system to a degree of sensitivity beyond that of ordinary superregenerative opera-

tion or true negative resistance, said means comprising a variable condenser serving to couple the antenna to said circuits.

4. In a radio receiving system for ultra high frequency signal energy, a vacuum detector tube including cathode, plate and control elements, a circuit tuned to the frequency of the signal energy, and operatively connected across the plate and control elements of the vacuum tube, said circuit including a tuned inductance, a source of B battery potential having its negative terminal connected to the cathode, an audio output transformer having its primary connected in series with the positive terminal of the B battery potential, another inductance resonant to a supersonic frequency, one terminal of said inductance being connected to the primary of the audio frequency transformer and the other terminal being connected to the electrical mid point of the first named inductance, an antenna, and a reactance serving to couple the antenna to the first named circuit, said reactance having a value less than that required for conventional super-regenerative operation of the system and such that the system is hypersensitive to reception of signal energy.

5. In a radio receiving system for ultra high frequency signal energy, a vacuum detector tube including cathode, plate, and control elements, a tuned inductance resonant to the signal energy and having its terminals operatively connected across the plate and control elements, a source of B battery potential having its negative terminal connected to the cathode, an audio frequency output transformer having its primary winding connected in series with the positive side of the source of B battery potential, a second inductance resonant to a supersonic frequency substantially less than the frequency of the signal energy, said inductance being connected in series with the primary of the audio frequency transformer and the electrical mid-point of the first-named inductance, an open-ended looped conductor coupled with the last-named inductance, one end of said conductor being connected to the cathode, an antenna, and a reactance serving to couple the antenna to the circuit formed by the first-named tuned inductance, said reactance being at a value less than that required for operation of the system according to conventional super-regeneration and such that the system is operated at hyper-sensitivity.

6. In a radio receiving system for ultra high frequency signal energy, a vacuum tube detector including cathode, plate and anode elements, a circuit connected across the plate and the control elements, said circuit including an inductance tuned to the frequency of the signal energy and also a grid leak and grid condenser, a source of B battery potential having its negative terminal connected to the cathode, an audio frequency transformer having its primary serially connected with the positive side of the source of B battery potential, a second tuned inductance serially connected between the electrical mid-point of the first-named tuned inductance and the primary of the audio frequency transformer, a pair of condensers in series with each other and connected across the terminals of said last-named inductance, one of said condensers having a relatively high capacitance and serving as a by-pass condenser, and the other having a relatively small capacitance and serving to tune the inductance to a supersonic frequency substantially less than the frequency of the signal energy, a connection between the cathode and the point of inter connection between said condensers, an open-ended looped conductor coupled to the second-named inductance, one end of said looped conductor being connected to the cathode, an antenna, and a reactance serving to couple the antenna to the first-named circuit, said reactance having a value less than that required to operate the system in accordance with conventional super-regeneration and such that the system is hypersensitive.

7. In a radio system for ultra high frequency signal energy, a pair of looped conductors disposed in spaced parallel planes, and electrically coupled together, a vacuum tube including cathode, grid and plate elements, a source of B battery potential having its negative terminal connected to the cathode, an inductance connected in series with one terminal of one of the looped conductors and the positive side of the source of B battery potential, the other end of said one looped conductor being connected to the plate element, a connection between one terminal of the other looped conductor and the plate, a radio frequency choke connected between the cathode and the other terminal of the other looped conductor, an open-ended looped conductor coupled to the first-named inductance, one end of said last-named conductor being connected to the cathode.

8. In a radio system for ultra high frequency signal energy, a vacuum tube having cathode, plate and grid elements, input and output circuits connected to the elements of the vacuum tube, a pair of hemispheres formed of conductive material, the peripheries of said hemispheres being in adjacent spaced relationship, and an inductance tuned to the frequency of the signal energy included in said circuits and disposed within said hemispheres in a plane adjacent the medial plane between the hemispheres so that a "fly-wheel" action results with extremely small amount of impedance.

9. In a radio system for ultra high frequency signal energy, a vacuum tube including cathode, plate and control elements, oscillatory circuits connected to said elements, said circuits including an inductance tuned to the frequency of the signal energy, a pair of hemispheres formed of conductive material, the peripheries of said hemispheres being in adjacent spaced parallel relationship, said inductance being in the form of a flat loop disposed in a plane adjacent the medial plane between the hemispheres, reactive means serving to couple said looped conductor to one hemisphere, and an antenna conductively connected to the mid point of said one hemisphere.

10. In a radio system for ultra high frequency signal energy, a pair of hemispheres formed of conductive material, the bases of said hemispheres being in juxtaposition and in spaced parallel relationship, a vacuum tube having cathode, plate and control elements, an input circuit connected across the control and cathode elements, said input circuit having two spaced points of connection to the periphery of one of the hemispheres, whereby said hemisphere is made an inductive element of the input circuit, said output circuit also having two spaced points of connection to the periphery of the other hemisphere whereby the other hemisphere is likewise made an inductive element of the output circuit, and an antenna conductively connected to the center of said last named hemisphere.

ELMER L. BROWN.