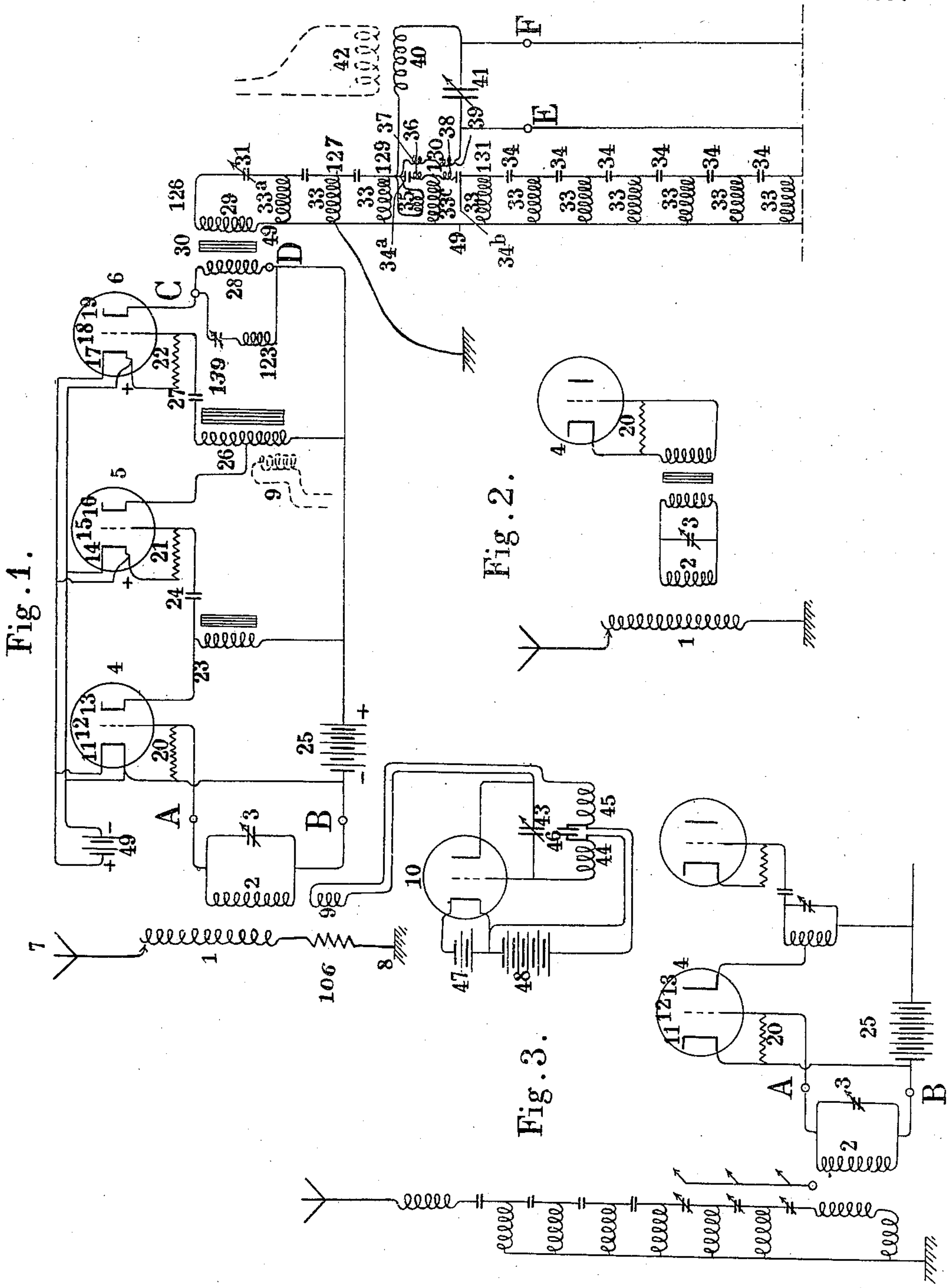
May 29, 1923. 1,457,069

L. LEVY

RECEIVING SYSTEM FOR ELECTRIC WAVES

Filed Sept. 27, 1919 5 Sheets-Sheet 1



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RECEIVING SYSTEM FOR ELECTRIC WAVES

Filed Sept. 27, 1919 5 Sheets-Sheet 2

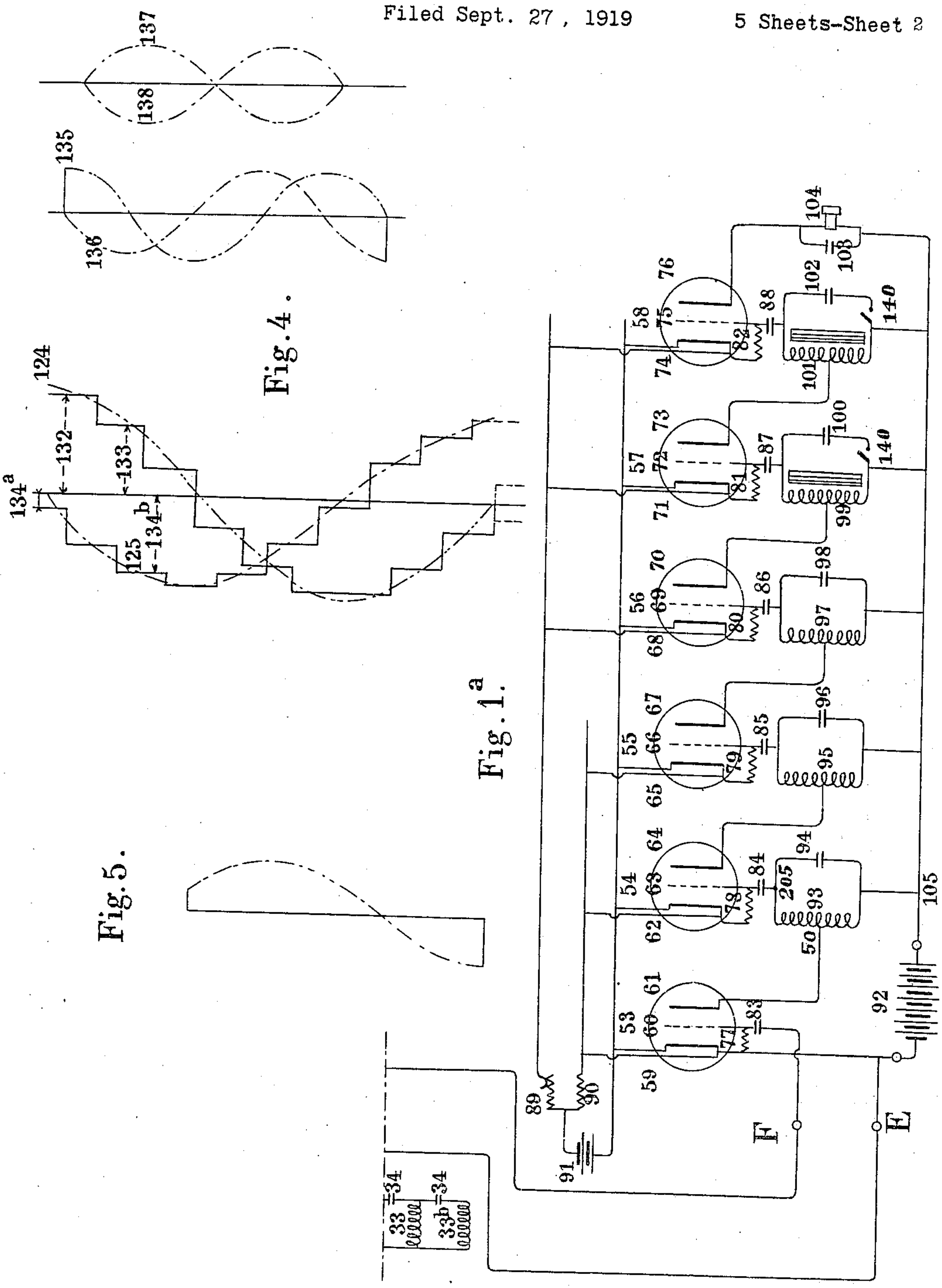

Fig. 4.

Fig. 5.

Fig. 1a.

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RECEIVING SYSTEM FOR ELECTRIC WAVES

Filed Sept. 27, 1919 5 Sheets-Sheet 3

Fig. 6.

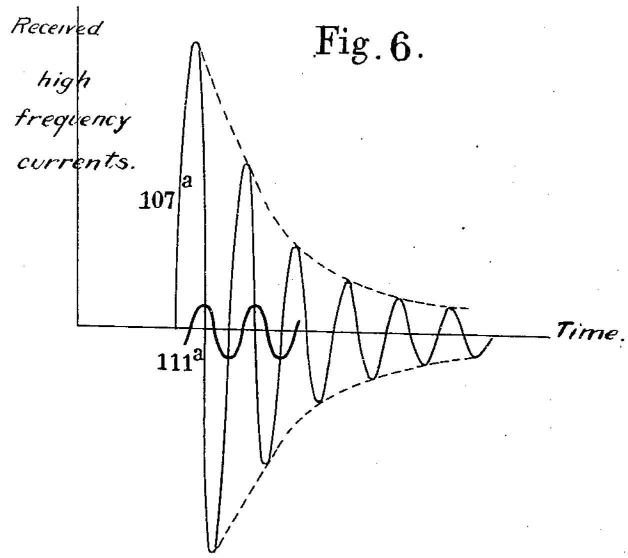


Fig. 9.

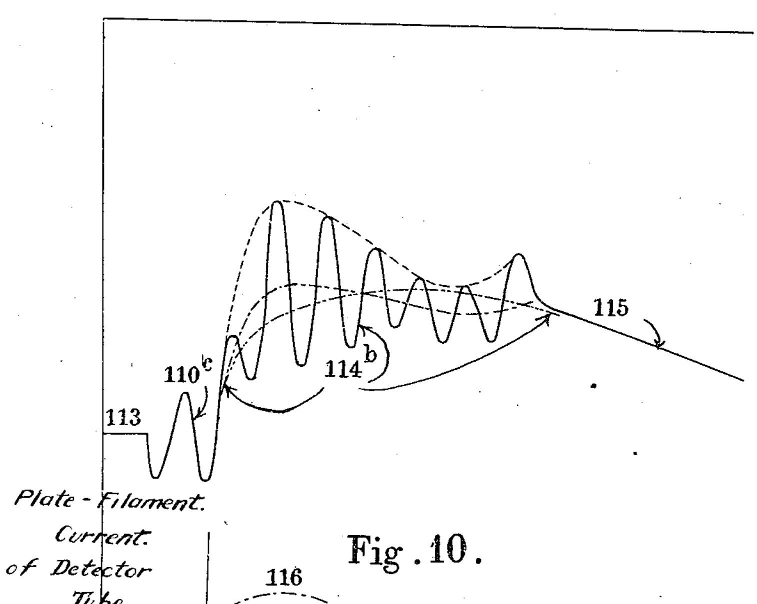
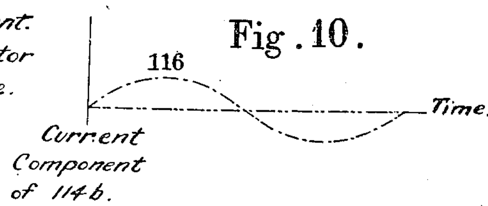


Fig. 10.



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RECEIVING SYSTEM FOR ELECTRIC WAVES

Filed Sept. 27, 1919 | 5 Sheets-Sheet 4

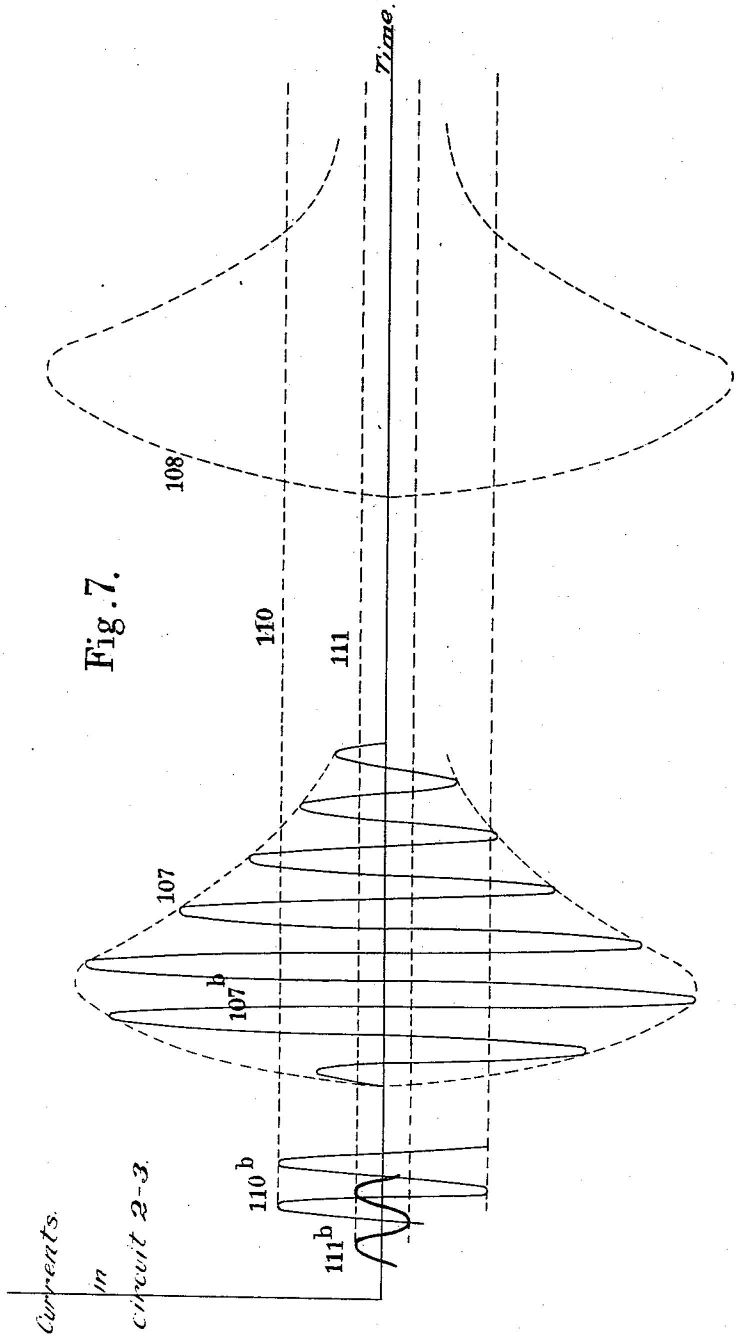

Fig. 7.

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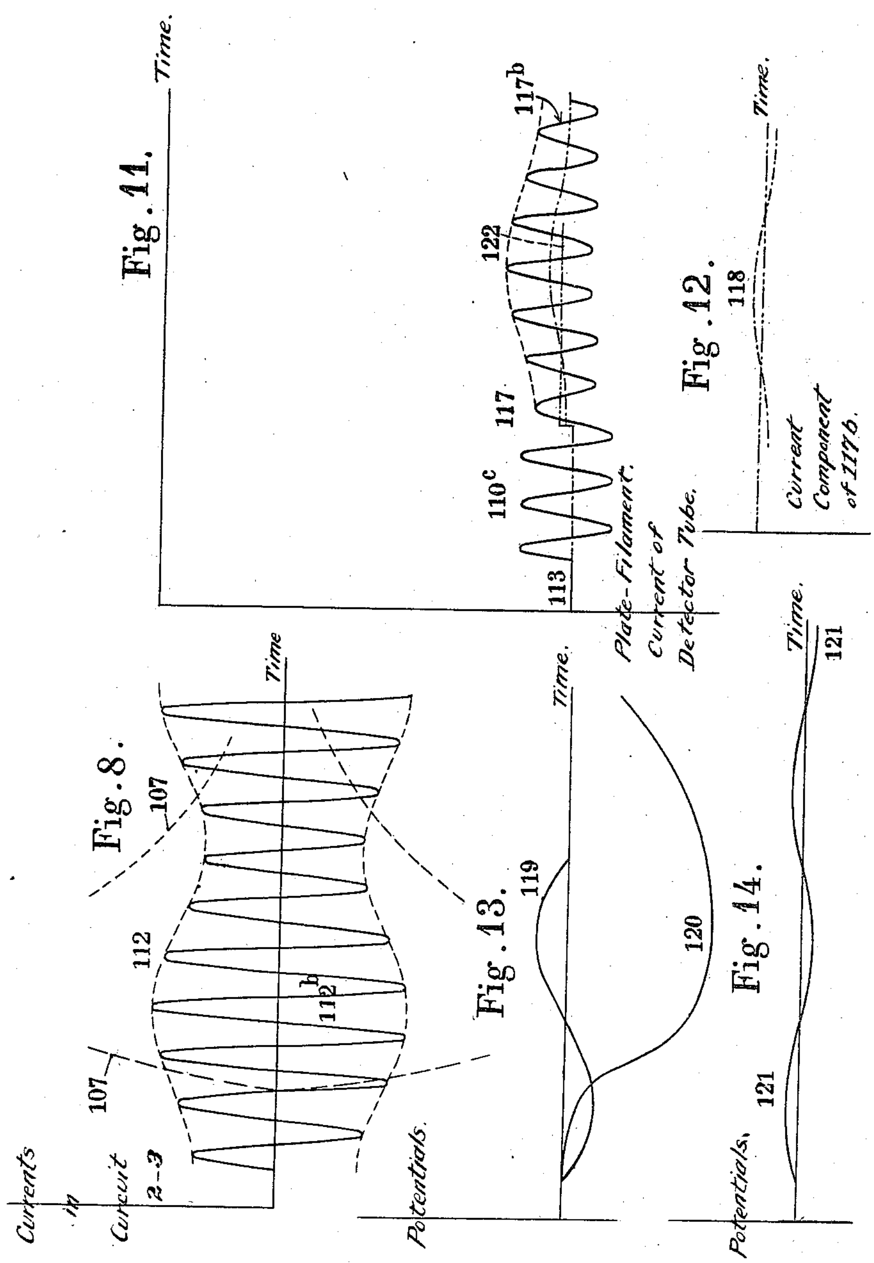
RECEIVING SYSTEM FOR ELECTRIC WAVES

Filed Sept. 27, 1919 5 Sheets-Sheet 5



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Patented May 29, 1923. **1,457,069**

UNITED STATES PATENT OFFICE.

LUCIEN LEVY, OF PARIS, FRANCE.

RECEIVING SYSTEM FOR ELECTRIC WAVES.

Application filed September 27, 1919. Serial No. 326,993.

To all whom it may concern:

Be it known that I, Lucien Levy, of 58 Rue de Verneuil, Paris, France, have invented a Receiving System for Electric Waves, of which the following is a full, clear, and exact description.

In the specification of patent application Serial No. 249.572, filed August 12, 1818, the applicant has described a system of electric transmission at a distance, applicable to wireless telegraphy and telephony and comprising a special transmitting station device and a special receiving station device.

In this patent it was specified that this receiving station device could be combined with a local generator permitting it to receive the ordinary emissions of the continuous wave stations under sufficient conditions of selectivity in spite of the disturbances of spark stations or atmospheric parasites.

In the case of this latter application, the receiving system comprising as its essential characteristics as has been stated in the patent, the following elements:—

1. Receiving circuits ordinarily employed or primary detecting selectors tuned to the frequency of the continuous wave to be received.

2. A local generator of high frequency coupled to the primary detecting selector circuits and tuned to a frequency different from that of the continuous wave to be received, the difference in the numbers of periods per second being a high number (of the order of 10,000 for example) so as to produce ultra-acoustic beats at a high frequency generally inaudible by the combination in the primary detecting-selector circuit of the two induced currents, the one by the aerial receiving circuits of the continuous wave and the other by the local generator.

3. Secondary detecting selector circuits tuned to the frequency of the ultra-acoustic beats.

4. A current generator of ultra-acoustic frequency coupled to the secondary detecting selector circuits and tuned to a frequency near to the ultra-acoustic frequency of the above mentioned beats, in such a way that there are produced, in the secondary detecting selector circuits, beats of acoustic frequency by the combination of the two currents of ultra-acoustic frequency.

5. If necessary selector circuits tuned to the frequency of acoustic beats.

The present application has for its object an improvement made in the receiving system described in the original application of the applicant in the case of its application to waves emitted by ordinary stations, for the purpose of obtaining a more complete selectivity and a greater protection against atmospheric parasites.

These improvements consist in:—

1. A special method of secondary selection based on the original principle described and comprising also various complementary operations intended to ensure efficient working of the system in all cases, even when the parasitic disturbances or confusion are very intense.

2. Arrangements which permit of the practical carrying out of the improved method and ensuring very great sensitiveness of the system.

The present improved method comprises, broadly, the following operations consisting:

1. In producing in the primary detecting selector circuits, before the first detection, beats of adjustable amplitude and of adjustable ultra-acoustic frequency (of the order for example of 10,000 per second) between the currents induced in the circuits by the oscillations of the receiving antenna and the current which is induced by a local generator of high frequency.

2. In amplifying and then detecting these beats in a detecting amplifier of high frequency.

3. In separating the numerous periods of current of ultra-acoustic frequency furnished by the detection of the beats of the continuous wave, from some periods of limited amplitude and very small in number, (one or two furnished by parasites) and from the currents of low frequency coming from the succession of the parasites: this selection taking place in a secondary selector the working of which, is based generally on the known phenomena of propagation of electric waves of systems with capacities and self inductors distributed in a relatively small number of elements.

4. In amplifying the selected currents of ultra-acoustic frequency and in transforming them into current of acoustic frequency by causing them to beat with a local current of ultra-acoustic frequency and then in detecting the beats obtained.

5. In effecting a selection on the acoustic frequency.

The production of the beats of high ultra-acoustic frequency in the primary selecting circuits is obtained by coupling inductively or by any method either to the receiving antenna, or to the primary selecting circuit coupled thereto, or to one of the circuits of the amplifying arrangements for the high frequency currents received by the antenna, a local generator of high frequency, the frequency of oscillation of which is chosen in such a way as to differ from the frequency of the receiving station (at which the primary selecting circuits are adjusted) by a number of periods per second equal to the ultra-acoustic frequency to be obtained.

The present mode of secondary selection is applicable likewise to the primary selection and to the acoustic selection.

The accompanying drawing shows by way of example an installation which permits of the carrying out of the present invention.

Figures 1 and 1ª show an antiparasitic receiving station of high selectivity for the reception of continuous waves.

Figures 2 and 3 represent modifications of detail.

Figures 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 represent diagrammatic representations of the currents in the different parts of the system.

In the method of carrying out the invention shown in Figure 1, the receiving station comprises:

1. A primary selector constituted by receiving circuits similar to those ordinarily employed in wireless telegraphy and comprising a self inductor 1 connected on the one hand to the antenna 7 and on the other hand to the earth 8 with the interposition of the non-inductive resistance 106. This self inductor is coupled by induction to the oscillating circuit 2, 3 relatively damped.

2. An amplifier and detector of high frequency represented between the terminals A, B and C, D and comprising three vacuum tubes 4, 5, 6 mounted so as to exert successively an amplifying and detecting action on the high frequency currents.

The filaments 11, 14, 17 of these three tubes 4, 5, 6 are heated in parallel by the accumulator 49.

The three plate filaments circuits of the three tubes are supplied by one and the same plate battery 25.

The grid 12 and the filament 11 of one tube 4 are connected respectively to the two terminals A, B of the oscillating circuit 2, 3 and a resistance of high value 20 is placed in shunt between 11 and 12.

In the plate circuit of the tube 4 is interposed the primary winding of an auto-transformer 23 of low distributed capacity and which can be provided or not with a finely laminated iron core. In the case in which no core is provided, this bobbin will be constituted for example by a spiral winding in several layers of wire preferably of copper, as fine as possible with comparatively thick insulation.

The grid 15 of the tube 5 is connected to the secondary winding of the auto-transformer 23 passing through a condenser 24 of low capacity.

The plate 16 is connected to the battery 25 passing through the primary winding of an auto-transformer 26 which may or may not have a core of finely laminated iron and is constituted if necessary in a manner similar to the bobbin 23: the secondary winding of this auto-transformer is constituted by the whole of the winding of the bobbin, although the primary winding thereof comprises for example only half.

The grid of the tube 6 is connected to the secondary winding of 26 through a condenser 27.

The auto-transformers 23, 26 might be replaced by choking coils.

The plate 19 and the battery 25 are connected respectively to the two terminals C, D on which is mounted the secondary selector, as will be hereinafter described.

3. A local generator of high frequency constituted for example by the vacuum tube 10 mounted as a generator of oscillations by magnetic coupling of the self inductors 44 and 45. Between the plate and the grid of this tube is mounted a variable condenser 43. Between the self inductors 44 and 45 is interposed a condenser of large capacity 46. A coupling coil 9 is interposed in the oscillating circuit 43, 44, 45 the proper oscillations of which are kept up by the tube 10.

The oscillating circuit 43, 44, 45, 9 is tuned to a frequency which is different from the individual frequency of the circuit 2, 3 by a high number of periods per second (for example of the order 10,000). The bobbin 9 is coupled inductively either to the self inductor 1, or to the self inductor 2, or to the self inductors 23 or 26.

The coupling between the oscillation generator and the primary selecting circuits may be effected by any well known means of coupling and take place at any point of the circuit from the antenna up to the primary winding of the auto-transformer 26 inclusively, that is to say before the primary detector 6.

4. A secondary selector properly so called or filter.

This secondary selector comprises a succession of condensers 34 mounted in series and self induction coils 33: the ends of these coils are connected respectively, some to the connections connecting the successive condensers the others to a common conductor 49 connected to earth.

These condensers and self inductors are designed so as to fulfil the following conditions:

(*a*) the whole offers a minimum of impedance for the ultra-acoustic frequency equal to the difference of the individual frequencies of the circuits 2, 3 and 43, 44, 45:

(*b*) the values of the condensers and of the self inductors are determined in such a way that at a given instant the currents distributed over the selector traverse a group of successive condensers in one direction and the next group in the reverse direction, and these currents of ultra-acoustic frequency change their direction at intervals comprising *n* condensers "*n*" being any member from 2 to 6, and 6 in the example shown in the drawing, that is to say that nodes of current are produced in this case and in permanent state approximately every six condensers.

The extreme self inductors 33^a and 33^b have generally a value which is double that of the self inductors 33. The two ends of the self inductor 33^a are connected to the terminals of the secondary winding 29 of a step down transformer 30 the primary winding of which is branched between the terminals C, D.

A variable condenser 31 is preferably interposed between the terminal 126 of the secondary winding of this transformer and the terminal 127 of the self inductor 33^a.

On the section of the line connecting the two condensers 34^a, 34^b, between which is produced a change of direction of the current, are mounted in series two self inductors 36, 38 arranged on either side of the self inductor 33^c.

These two condensers 34^a, 34^b have a capacity which is less than that of the condensers 34. The self inductor 33^c similar to the self inductors 33 is coupled to a self inductor 35.

Two self inductors 37, 39 coupled respectively to the self inductors 36, 38 are mounted in series with the self inductor 35 and a self inductor 40 on the terminals of a variable condenser 41.

The oscillating circuit 35, 37, 39, 41, 40 must have the minimum of damping possible and is tuned approximately to a frequency equal to the difference of the individual frequencies of the oscillating circuits 2, 3, and 43, 44, 45, 49, that is to say to a frequency of the order of 10,000 for example.

The system of self inductors 33, 33^a, 33^b, 33^c, 36, 38 and the condensers 34, 34^a, 34^b constitutes an artificial inverse line. This latter may comprise a different number of elements.

5. A resonance detecting selector amplifier generator for low frequency constituted by a certain number of three electrode vacuum tubes, 53, 54, 55, 56, 57, 58 the filaments of which 59, 62, 65, 68, 71, 74 are heated in parallel and the plate filament circuits of which have the plate battery 92 in common.

The terminals E, F of the oscillating circuit, 35, 37, 39, 41, 40 are connected respectively to the grid 60 and to the filament 59 of the tube 53, with the interposition of a stop condenser 83 and the arrangement of a large resistance 77 between 59 and 60.

The plate 61 of this tube 53 is connected at an intermediate point 50 to a self inductor 93 of low distributed capacity and which may be or may not be provided with a finely laminated core of iron. The plate circuit 61, 50, 105, 92 of this tube 53 passes through the primary winding 50, 105 of the auto-transforming self inductor 93 and, through the battery 92, the secondary winding 93 of this auto-transformer is in parallel with a condenser 94, the connection 205 being connected to the grid 63 of the tube following (54) passing through the stop condenser 84 of this latter, the connection 105 being connected to the filament 62 of this tube by way of the battery 92. As before, a large resistance 78 is arranged in shunt between 63 and 62.

The same system of connection which has just been described between the plate circuit 61, 93, 105, 92 of the tube 53 and the grid circuit 63, 84, 106, 105, 92, 62 of the next tube 54 is reproduced between the following tubes.

The oscillating circuits 93—94, 95—96, 97—98 are tuned to a frequency which is near to that of the frequency of the ultra-acoustic beats.

The stop condensers 85 and 86 of the tubes 55, 56 have a capacity near to that of the stop condenser 84; however, the capacity of the condenser 86 is slightly smaller, and the large resistances 79, 80, 81, 82 corresponding to the tubes 55, 56, 57, 58 are similar to the resistance 70.

In the plate circuit of this last tube 58 is interposed the receiving telephone 104 shunted by a condenser 103.

The two oscillating circuits 99, 100 and 101, 102 of the tubes 57 and 58 are tuned for an acoustic frequency near to the maximum of sensitiveness of this telephone 104. The self inductors 99 and 101 are generally iron cored.

The stop condensers 87 and 88 present for the current of acoustic frequency an impedance of the same order as that of the condenser 84 for the current of ultra-acoustic frequency.

Working.

In Figures 6, 7, 8, 9, 10, 11, 12, 13, 14 is shown the curves of the variations of the currents circulating in different parts of the circuits in action at the same time, the time being denoted by the abcissæ and the currents by the ordinates.

Under the action of a continuous emission to which the antenna is tuned, the self inductor 1 is traversed by an alternating current of high frequency 111^a, (see Figure 6): simultaneously, damped alternating currents 107^a arising either from the individual oscillation of the antenna under the influence of parasitic shocks highly damped or of the induction waves having the same period as that to which the antenna is tuned, circulate in this self inductor.

These currents induce respectively in the oscillating circuit 2, 3 which is suitably damped currents of which only a few periods and their envelope are shown (Fig. 7). These induced currents are:

1. A sinusoidal alternating current 111^b the envelope of which is 111.

2. Damped currents, such as 107^b with envelopes 107, 108 arising from parasitic shock or damped emitting stations.

3. Furthermore in this circuit, the generator 10 induces the alternating sinusoidal current 110^b the frequency of which differs from the frequency of the current 111^b by a number of periods corresponding to an ultra-acoustic frequency. The current which circulates in the circuit, 2, 3 results from the composition of the three currents above enumerated.

The composition of the currents 110^b and 111^b is indicated in Figure 8. In this figure is shown the production of beats 112^b of mean ultra-acoustic frequency by the combination of the current coming from the continuous wave station with the current coming from the local generator.

The figure represents the case in which the continuous wave has a frequency of 60,000 periods per second. The generator 10 induces a frequency of 70,000; 10,000 beats per second are produced.

The parasite current 111 being of short duration can only give at the maximum one or two beats to 10,000 periods, the amplitude of these beats being adjustable and having for their maximum amplitude that of the current induced by the local generator.

Furthermore, it is important to note that the amplification relatively due to the action of the local generator is infinitely greater for the feeble continuous wave station than for the strong parasite and can be adjusted to the maximum value by variation of the amplitude of the oscillations induced by the local generator.

These beats and currents of high frequency are amplified by the tube 4 the plate circuit of which is traversed by identical currents. The high frequency potential differences which develop at the terminals 23 are transmitted by the condenser 24 to the grid of the tube 5.

In like manner the currents and beats of high frequency amplified which circulate in the primary winding of 26 are transmitted to the grid 18 of the tube 6 which acts as a detector in a manner well known. It should be noted that a portion of the energy of the parasite current had been absorbed by a first detection due to the tube 5, although the continuous wave of much lower intensity was transmitted without detection.

The plate circuit 19, C, D, 25, 17 of the tube 6 is traversed by the currents coming from the detection of the high frequency currents and beats.

Figures 9 and 10 indicate the effect produced by the parasite, and Figures 11 and 12 that produced at the station by continuous waves 111^b of Figure 7.

For the sake of clearness in the drawing, the two currents, one of which is due to the parasite and the other to the continuous wave, have been separated.

In reality these two currents are superposed.

The line 113 represents the permanent current in the plate circuit. The line 110^c represents the effect of the local generator on the current of the plate circuit. The line 114^b represents the effect of interference between the parasite and the local generator. The line 115 represents the variation of the permanent current due to the charge of the condenser 27 under the effect of the train of parasitic waves.

It is easy to ascertain that the currents, circulating in the plate circuit 19, C, D, 17 under the influence of parasites and becoming superposed on the permanent current, may be decomposed into:

1. Impulses such as 115 having a relatively large duration with respect to the ultra-acoustic period and succeeding each other at a low frequency.

2. A current period of ultra-acoustic frequency 116 (see Figure 10) having a limited amplitude, whatever be the magnitude of the parasite, of a value which is adjustable by variation of the coupling between the bobbin 9 and the self inductor 2.

3. A train of high frequency waves.

The effect of the combination of the continuous waves station and the local generator is represented in Figure 11 at 117^b.

The current circulating in this same plate circuit under the influence of the continuous wave station is composed:

1. of a change of the mean current 122 corresponding to each signal.

2. of an alternating current of ultra-

acoustic frequency having a large number of periods (a hundred for example) the amplitude of which is for example at least superior to the tenth of the amplitude of the ultra-acoustic effect of the parasite: some periods of this current have been represented at 118, (see Figure 12).

3. of an amplified alternating current of high frequency.

The high frequency currents may be shunted by the circuit 139, 123 (Fig. 1) which offers a very low resistance to their passage.

Moreover, even by doing away with 105, 123, the high frequency currents will be strongly throttled by the iron self inductor 28.

In the case in which the high frequency of the waves received is very high and, consequently very different from the ultra-acoustic frequency, the self inductor 123 may be dispensed with.

Under these conditions, only the currents of ultra-acoustic frequency and low frequency pass into the transformer C, D.

Figure 13 shows quite diagrammatically the difference of potential 119, 120 at the terminals of 29 under the effect of the parasite, and Figure 14 shows at 121 that corresponding to the continuous wave.

Experience has shown that it was useless to try to separate the effect of violent parasites from that of the continuous wave by constituting the secondary selector of an oscillating circuit. This latter as a matter of fact is excited by shock under the influence of the low frequency current 120, which transforms each parasitic shock into ultra-acoustic current, so that the elimination of parasites is not effected. It is therefore indispensible to have recourse to new methods of selection derived from a modification considered in the original patent and constituting an efficient secondary selector.

Under the effect of the alternating current 121 supplied by 29 on the system of self inductors and distributed capacity 32, 33, 34, 35, 36, 38, 52, 50 constituting an artificial inverse line, stationary waves are produced, when this system is tuned to vibrate in resonance with the ultra-acoustic current furnished by the continuous wave station.

The line 124 represents the current traversing the condensers 34 and the conductors which connect them, the line 125 represents the potential along the line. For example the arrows 132, 133 indicate the values of the currents between the terminals 127, 128, and the terminals 128, 129, respectively, while the arrows 134^a and 135^b indicate the E. M. F.'s across 127, 49, and 128, 49 respectively and so on.

The line 135 represents diagrammatically and generally, stages having been eliminated, the distribution of the current over a 5/4 wave line at the instant the current is greatest, when the permanent state is established, the wave length being defined as the constant distance reckoned on the line (by the number of meshes for example) between two points where the current and the tension have the same value and the same direction.

The currents at different points of the line (which flow through condensers) are in phase and have a lead of approximately 90 degrees to the potentials at the same points (measured on the coils).

On the contrary, the parasite cannot give stationary waves since it produces only one period of ultra-acoustic current. A free wave is propagated over the inverse artificial line in such a way that the potential varies at each point in phase with the current. The line 137 representing the current at a given instant, the distribution of the potential is 136. Under these conditions, if the coupling 39, 38 be reversed with respect to the coupling 37, 36, a tension in phase with the tension at the terminals of 35 will be obtained over the whole 37, 39. These two tensions may be opposed for a suitable choice of the direction of the coupling 35, 52 in the case of the free wave. For the stationary wave on the contrary, the two tensions induced being put out of phase by 90 degrees will be added geometrically for the same arrangement of the couplings. The ultra-acoustic effect of the parasite on the oscillating circuit 35, 37, 39, 41, 40 may be cancelled although the ultra-acoustic effect of the continuous wave station will be augmented.

On the other hand, the current of low frequency due to the parasite will not be able to propagate itself over the line: the wave length of the parasite current which is proportional to the square of the frequency being small for low frequencies only covers a small number of condensers. Under these conditions, there is reflexion of the low frequency current and enormous weakening of the said current along the line.

All the effects of the parasite being annulled, there only remains those of the continuous wave station which causes the circuit 35, 37, 39, 41, 40 to oscillate.

The oscillations of this circuit are amplified by means of the three vacuum tubes 53, 54, 55, the oscillating coupling circuits of which 93—94, 95—96, 97—98 are slightly put out of tune with the frequency of the circuit 35, 37, 39, 41, 40. Good experimental results have been obtained with the condensers 94, 96, 98 being greater than the value of resonance and increasing in this order. Under these conditions, the system, due particularly to light magnetic couplings between the different circuits, starts to oscillate at an ultra-acoustic frequency slightly different from that of the current of the continuous wave station. There is produced by the combination of the current engendered by the oscillation proper to the system and that arising from the transformations of the continuous wave, beats of acoustic frequency which are detected by the tube 56 and transformed into current of acoustic frequency. It should be noted: 1. that this system which is auto-excited and of ultra-acoustic frequency possesses a much greater receiving sensibility for feeble currents than for strong ones, which is very favourable to the reception from feeble stations: 2. that the acoustic beats can always be limited in amplitude.

This acoustic frequency being adjustable by variation of the high frequency induced by the generator 10 in Figure 1 can be brought to be the frequency of resonance of the circuits 99—100 and 101—102 and of the telephonic headpiece (104) which might be replaced by a resonance galvanometer.

If the circuits 93, 94—95, 96—97, 98 are sufficiently damped (for example by taking resisting self inductors or by varying the heating of the filaments by the rheostat 90) no ultra-acoustic oscillations will be generated. In this case, the circuits 93—94, 95—96, 97—98 are tuned to the ultra-acoustic frequency of the circuit 35, 37, 39, 41, 40.

In the case of the reception of continuous waves coming from a wireless telephone station, the acoustic selection is dispensed with, the condensers 100, 102, cut out by switches 140 and 141, and the auto-excitation of the amplifier done away with by reducing the heating by means of the rheostat 90.

Finally, it is possible to replace the local heterodyne generator 10 by an auto-excitation at high frequency (auto dyne) of the detecting amplifier AB, CD obtained by causing the amplified currents to act on the oscillating circuit 2, 3 for example by a magnetic or electric coupling of the circuits in which these currents circulate with the circuit 2, 3.

Figure 2 represents a modification in which a transformer (an iron cored one for example) has been interposed between the oscillating circuit and the first grid so as to damp this circuit by a greater consummation of energy of the grid circuit of the lamp 4.

The inverse artificial line arrangement employed for the secondary selection may likewise be employed:

1. for the primary selection and for the acoustic selection and generally every time there is a question of separating a disturbance of an alternating current the period of which is shorter than the duration of the disturbance.

2. for the separation of a train of waves of some periods from a train of waves constituted by a large number of periods.

For the latter purpose, it is important to note that in place of employing an inverse artificial line as described and shown in Fig. 1, a direct artificial line might be employed this line being constituted by transposing in the inverse artificial line the self inductors 33 and the capacities 34 or even other systems more complicated without changing the spirit of the invention.

Figure 3 shows the arrangement on the antenna of a device intended to reduce considerably the excitation by shock of the antenna to the frequency of the wave for which the whole of the apparatus is adjusted. As will be seen from the diagram, the same arrangement of inverse artificial line is employed as for the secondary selector. Fig. 5 indicates diagrammatically the distribution of the current excited in the antenna by the receiving continuous wave station.

In Figure 3, an inverse artificial lines has been arranged in series with the antenna for the purpose of diminishing the propagation, over the antenna and artificial line system, of electric shocks having a duration longer than the period over which the system is regulated and which it is intended to receive.

If on the contrary it was desired to be protected against shocks of shorter duration than this, it would suffice to place in series with the antenna an ordinary direct artificial line.

Furthermore, instead of putting these lines in the lower part of the antenna, even the elements of direct and inverse artificial lines might be distributed over the antenna.

More complicated combinations of direct and inverse lines may also be utilized without changing the spirit of the invention, the characteristic point of this part of the invention being the fact that for the frequency to be selected the number of condensers or self inductors per wave length is small, of the order of 9 for example, but more than 3, while for any electric shock of a duration different from the period to which it is tuned, the number of elements per wave length being less than 4, for example, the propagation is effected with very great weakening.

Claims:

1. In an antiparasitic selecting receiving system for electric waves:—means for selectively receiving on one tuned device electrical oscillating damped energy as well as sustained energy of the same primary frequency,—means for converting the frequency of this energy to lower but ultra-acoustical frequency energy,—means for separating in the ultra-acoustical frequency energies the sustained energy from the

damped energy,—means for utilizing the ultra-acoustical energy for actuating the indicating means of the receiving station.

2. In an antiparasitic selecting receiving system for electric waves:—means for selectively receiving on one tuned device electrical oscillating damped energy as well as sustained energy of the same primary frequency,—means for converting the frequency of this energy to lower but ultra-acoustical frequency energy,—means for separating in the ultra-acoustical frequency energies the sustained energy from the damped energy,—means for amplifying and transforming this ultra-acoustical energy into an acoustical frequency energy and utilizing it for actuating the indicating means of the receiving station.

3. In an antiparasitic selecting receiving system for electric waves: means for selectively receiving on a resonant device long wave-trains of any frequency and for attenuating the propagation on the system of short wave-trains of the same frequency or of electrical impulses,—means for amplifying and converting the received currents into currents of lower but ultra acoustical frequency, which frequency may be predetermined,—means for effecting a secondary selection on the ultra acoustical frequency locally created by the transformation of the current issuing from the transmitting station and for eliminating the currents produced by the confusing stations and the parasitic signals,—means for amplifying and transforming this current into an acoustical frequency current and utilizing it for actuating the apparatus of the receiving station.

4. In an antiparasitic selecting receiving system for electric waves: means for selectively receiving on tuned devices constituting a primary selector, waves of any frequency,—a local generator of high frequency current coupled to the circuits through which flow the primary high frequency current and producing ultra acoustical beats,—a primary detector-amplifier coupled to the primary selector, amplifying the beats and high frequency currents and transforming them into ultra acoustical frequency currents,—a secondary choke selector tuned to the ultra acoustical frequency and comprising an artificial line separating the ultra acoustical current issuing from the transmitting station currents, from the parasitic or confusing signals, means for amplifying the selected ultra acoustical current and transforming it into acoustical frequency current, and an indicating member actuated by this acoustical current.

5. In an antiparasitic selecting receiving system particularly adapted to radio-telephony and telephony,—means for selectively receiving on tuned devices constituting a primary selector, waves of any frequency,—a local generator of high frequency current coupled to the circuits through which flow the primary high frequency current and producing ultra acoustical beats,—a primary detector-amplifier coupled to the primary selector, amplifying the beats and high frequency currents and transforming them into ultra acoustical frequency currents,—a secondary choke selector tuned to the ultra acoustical frequency and comprising an artificial line separating the ultra acoustical current issuing from the transmitting station currents, from the parasitic or confusing signals,—means for amplifying the selected currents and transforming them into currents to the voice frequency,—a receiving apparatus of low frequency current.

6. In a selecting receiving system:—means for transforming the received current into a succession of predetermined frequencies current issuing successively from each other a plurality of oscillating circuits tuned to the predetermined frequencies and means for tuning, by only one adjustment simultaneously, of all the frequencies locally created on the predetermined oscillating circuits.

7. In a selecting receiving system in combination:—a receiving circuit adjustable to any frequency,—an heterodyne generator adjustable to other frequencies for giving predetermined secondary frequency beats,—a plurality of circuits tuned to predetermined frequencies the first being tuned to the secondary frequency,—a generator tuned once for all on another secondary frequency for giving tertiary frequency beats.

8. In a selecting receiving system in combination:—a receiving circuit adjustable to any primary frequency,—means for converting the primary frequency in a predetermined secondary frequency,—an auto-excited circuit tuned to the secondary frequency and generating oscillation to another predetermined secondary frequency for producing tertiary frequency beats between the two predetermined secondary frequencies.

9. In a selecting receiving system:—means for transforming a received current of any frequency into a predetermined frequency current,—a plurality of oscillating circuits tuned to this predetermined frequency for amplifying selectively this predetermined frequency,—and means for obtaining the tuning by one adjustment by varying the frequency produced by the converting device.

10. In a selecting receiving system, primary selecting circuits tuned to the frequency of the wave to be received,—a local generator of high frequency current causing the production of predetermined ultra acoustical frequency beats,—means for am-

plifying and detecting these beats and transforming them into ultra acoustical predetermined frequency currents,—means previously tuned to the predetermined ultra acoustical frequency for selecting, amplifying and transforming the ultra acoustical current into audible predetermined frequency currents,—and means tuned to a predetermined audible frequency for selectively amplifying this audible frequency current.

11. In a selecting receiving system, primary selecting circuits tuned to the frequency of the wave to be received,—a local generator of high frequency current causing the production of predetermined ultra acoustical frequency beats,—means for amplifying and detecting these beats and transforming them into ultra acoustical frequency current,—means previously tuned to the predetermined ultra acoustical frequency for selecting, amplifying and transforming the ultra acoustical frequency current into predetermined audible frequency current.

12. In a selecting receiving system for electric waves a selecting system for separating an impulse or damped wave-train from a long wave-train comprising in combination:—an artificial line constituted by impedances having such values that the line is tuned on the frequency to select, and being in such number that the line comprise a number of wave-lengths greater than the number of periods of the damped wave-train,—means for separating the free wave caused by the impulse or the short wave-train propagating on the artificial line from the stationary waves which are produced therein by the long wave-train.

13. In a selecting receiving system, for electric waves a selecting system for separating an impulse or damped wave-train from a long wave-train comprising in combination:—an artificial line constituted by impedances having such values that the line is tuned on the frequency to select, and that the number of elements by wave length is small and being in such number that the line comprise a number of wave lengths greater than the number of periods of the damped wave-train,—means for separating the free wave caused by the impulse or the short wave-train propagating on the artificial line from the stationary waves which are produced therein by the long wave-train.

14. In a selecting receiving system for electric waves a selecting system for separating an impulse or damped wave-train from a long wave-train comprising in combination:—an artificial line constituted by impedances having such values that the line is tuned on the frequency to select, and being in such number that the line comprise a number of wave-lengths greater than the number of periods of the damped wave-train,—a circuit coupled with different element of the artificial line for obtaining a balancing for free waves and not for stationary waves.

15. In a receiving device for electric waves, a multi-step medium and low frequency detector-selector-amplifier provided with vacuum tubes, comprising, between the plate and grid-circuits of two consecutive tubes, selecting oscillating circuits, a portion of the self-induction coil of each oscillating circuit being included in the plate-circuit of one of the tubes, the free end of this coil being connected to the grid of the next tube through a condenser, these oscillating circuits being tuned to ultra acoustical frequencies before the detecting tube and to acoustical frequencies after this tube and a plate-battery and a heating accumulator common to the ultra acoustical current amplifying tubes and the acoustical current amplifying tubes.

16. In a receiving device for electric waves, a medium and low frequency detector-selector-amplifier provided with vacuum tubes, comprising, between the grid and plate-circuits of two consecutive tubes, selecting oscillating circuits, a portion of the self induction coil of each oscillating circuit being included in the plate-circuit of one of the tubes, the free end of this self induction coil being connected to the grid of the following tube through a condenser, these oscillating circuits being tuned to ultra acoustical predetermined frequencies, before the detecting tube and to acoustical frequencies after the said tube,—a plate-battery and a heating accumulator common to the ultra acoustical current amplifying tubes and the acoustical current amplifying tubes,—means for producing an auto-excitation of the first tubes on a frequency slightly different from the ultra acoustical frequecy to be amplifed, these tubes acting as auto-generators of ultra acoustical frequency current, for the purpose of producing acoustical frequency beats and of transforming the amplified ultra acoustical current into audible frequency current.

The foregoing specification of my receiving system for electric waves, signed by me this 8th day of September 1919.

LUCIEN LEVY.