G. SEIBT.

RADIO-TELEPHONY.

APPLICATION FILED DEC. 20, 1907.

1,012,456. Patented Dec. 19, 1911.

Fig. 1.

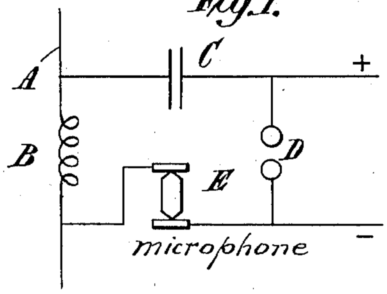


Fig. 2.

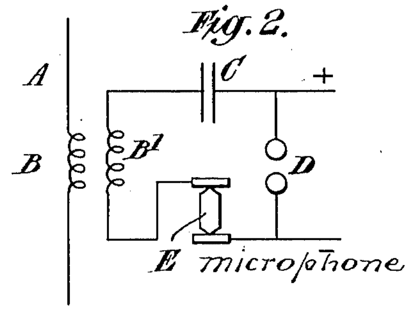


Fig. 3.

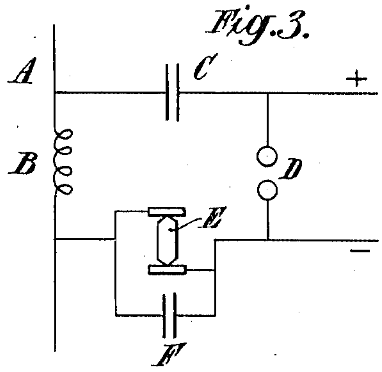


Fig. 4.

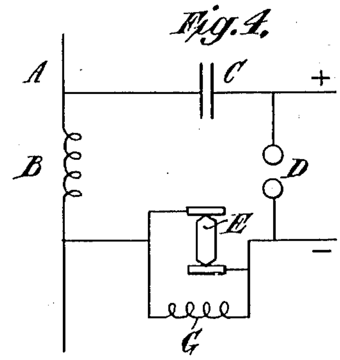
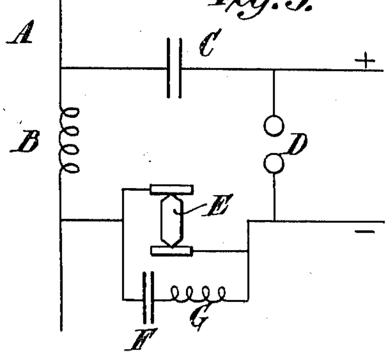


Fig. 5.



Witnesses:
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[illegible]

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his Att'ys.

UNITED STATES PATENT OFFICE.

GEORG SEIBT, OF BERLIN, GERMANY, ASSIGNOR TO THE AMALGAMATED RADIO-TELEGRAPH COMPANY, LIMITED, OF LONDON, ENGLAND.

RADIO-TELEPHONY.

1,012,456. Specification of Letters Patent. Patented Dec. 19, 1911.

Application filed December 20, 1907. Serial No. 407,397.

To all whom it may concern:

Be it known that I, GEORG SEIBT, a subject of the Emperor of Germany, residing at 13 Mathieustrasse, Berlin, in the Empire of Germany, have invented certain new and useful Improvements Relating to Radio-Telephony, of which the following is a specification.

This invention relates to radio-telephony, the chief object being to increase the efficiency of working of radio-telephonic systems.

It is well known that radio-telephony can be produced by means of electrical oscillations by subjecting the intensity of the oscillations produced by the human voice at the transmitting station to rythmical changes. For this purpose some device is required which will cause either the resistance, the inductance, or the capacity, or any combination of these factors, to vary in accordance with the variations of air pressure which constitute acoustic vibrations. That is to say, the alternate compression and rarefaction of the air must be made to produce corresponding changes in either the amplitude, or the periodicity, of the electrical radiations. The simplest form for such an arrangement is to insert a variable resistance, such as a microphone, directly into the antenna or into a circuit coupled with the antenna. By doing so there arises however the disadvantage—if microphones with any kind of resistance are chosen—that only a very small efficiency can be obtained by changing the vibrations of the air into variations of electrical intensity.

According to the present invention the variable resistance is brought into such relation to the fixed resistances that the variation of pressure produced by the acoustic vibrations causes a maximum variation of radiated electrical energy. In the case in which the oscillations are produced in the antenna itself or transferred to it by loose coupling from a closed oscillation-circuit, and assuming the microphone to be inserted directly into the oscillation circuit, theory shows that the resistance of the microphone ought to be numerically equal to the other resistances of the antenna, or in other words, that the damping produced by the microphone resistance ought to be the same as the damping produced by the resistance in the antenna itself. This is shown by the following consideration of an antenna excited by a loosely coupled closed oscillation circuit:—Let e represent the E. M. F. induced in the antenna, J the strength of the current, w_m the resistance of the microphone, and w the effective alternating current resistance of the antenna. Then, while having resonance, the strength of current is given by the following equation:—

$$J=\frac{e}{w+w_m}$$

If the resistance of the microphone is, owing to sound waves falling upon the microphone block or plate, varied by an amount $\triangle w_m$, J will be increased or diminished by an amount $\triangle J$. The value of $\triangle J$ is given by the equation:—

$$\triangle J=\frac{e}{w+w_m+\triangle w_m}-\frac{e}{w+w_m}$$

Therefore, assuming $(w+w_m+\triangle w_m)$ differs from $(w+w_m)$ by a negligible amount.

$$\triangle J=\frac{e\triangle w_m}{(w+w_m)^2}$$

If the resistance is only changed slightly as for instance by speaking, the value $\triangle w_m$ will generally be proportional to the strength of the sound wave and will also be proportional to the resistance of the microphone itself. If the intensity of the sound is kept constant, the microphone having double the resistance of another one which is equivalent to the first in regard to its efficiency will suffer the double variation in resistance. Therefore it can be said that:—

$$\triangle w_m=Kw_m$$

where K depends upon the intensity of the sound but not upon the resistance of the microphone. Substituting this value for $\triangle w_m$, the equation becomes:—

$$\triangle J=\frac{eKw_m}{(w+w_m)^2}$$

It is important for radio-telephony that $\triangle J$ becomes a maximum. Now $\triangle J$ is a maximum or minimum when

$$\frac{d\triangle J}{dw_m}=o$$

By differentiating $\triangle J$ with respect to w_m and equating to zero we obtain:—

$$\frac{d\triangle J}{dw_m}=\frac{eK(w+w_m)^2-2(w+w_m)(eKw_m)}{(w+w_m)^4}=\frac{eKw^2-eKw_m^2}{(w+w_m)^4}=o$$

Therefore $w=w_m$. Also

$$\frac{d^2\triangle J}{dw_m^2}=\frac{-2ekw_m(w+w_m)^4-4(w+w_m)^3(ekw^2-ekw_m^2)}{(w+w_m)^8}$$

and this being a negative quantity shows that the condition $w=w_m$ makes $\triangle J$ a maximum. Hence the condition for maximum efficiency is that the resistance of the microphone and of the system to which it is connected should be equal.

In the accompanying drawings, Figure 1 shows diagrammatically one method of carrying out my invention. Fig. 2 shows the antenna inductively coupled with an associated circuit. Fig. 3 shows the use of capacity in parallel with the variable resistance. Fig. 4 shows an inductance in parallel with such variable resistance. Fig. 5 shows capacity and inductance in series with each other and in parallel with the variable resistance.

A simple arrangement is shown in Fig. 1 of the accompanying drawings, in which A is the antenna, B an inductance, C a condenser, D the source of electrical oscillations, and E the microphone; the resistance of this microphone is equal to that of the system to which it is connected. Fig. 2 is similar to Fig. 1 with the exception that the antenna is inductively coupled to the oscillation circuit by means of the oscillation transformer B B′.

If the resistance of the microphone does not satisfy the above stated condition, its excess or lack of resistance may be compensated for; when the microphone has too high a resistance we may connect a condenser F or an inductance G of determined value in parallel with it as shown in Figs. 3 and 4 respectively; the effect of such a shunt circuit being to take part of the current and thus compensate for too high a resistance of the microphone alone. When the microphone has too low a resistance, a condenser and an inductance in series may be placed in parallel with it as shown in Fig. 5. The condenser and inductance in series connected across the microphone constitute an oscillatory circuit, which if adjusted out of tune with the received oscillations would tend to damp them, and in this way compensate for too low a resistance of the microphone alone. The same may be done when the microphone, instead of being inserted into the antenna, is inserted into a closed circuit loosely coupled with the antenna as it is in Fig. 2. In the case of a shunt circuit being employed with the microphone, the damping due to the microphone and shunt circuit in combination should be equal to the damping due to the resistance of the rest of the system comprising the antenna. When the antenna is coupled rigidly to the oscillation-circuit there will be different relations between the proportion of the resistance of the microphone and the other resistances of the oscillation circuits on account of the circuits affecting each other mutually. But it is always desirable, even if the maximum were not very sharp, to keep the amount of energy consumed by the microphone equal or nearly equal to the energy spent in the system to which it is connected.

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

1. In a system of radio-telephony in which the transmitting apparatus comprises means for producing and transmitting electrical oscillations, and means comprising an ohmic resistance which coöperates with the first mentioned means and is capable of causing variations in intensity of the electrical oscillations by amounts corresponding to the variations of acoustic vibration produced by speaking; means for relatively adjusting the aforesaid ohmic resistance and the resistance of the system with which it coöperates until they are approximately equal.

2. In a system of radio-telephony in which the transmitting apparatus comprises means for producing and transmitting electrical oscillations, and means comprising electrical resistance coöperating with the first mentioned means for varying the electrical oscillations by amounts corresponding to variations of acoustic vibrations produced by speaking, means contained in a circuit shunted from the said electrical resistance for making the damping effect of the latter and of the shunt circuit in combination equal to that due to the resistance of the system to which they are connected.

In testimony whereof I affix my signature in presence of two witnesses.

GEORG SEIBT.

Witnesses:
WOLDEMAR HAUPT,
ARTHUR SCHROEDER.