April 13, 1937. G. G. JACQUET ET AL 2,076,724

ELECTROACOUSTIC SOUNDING APPARATUS

Filed Feb. 23, 1935 2 Sheets-Sheet 1

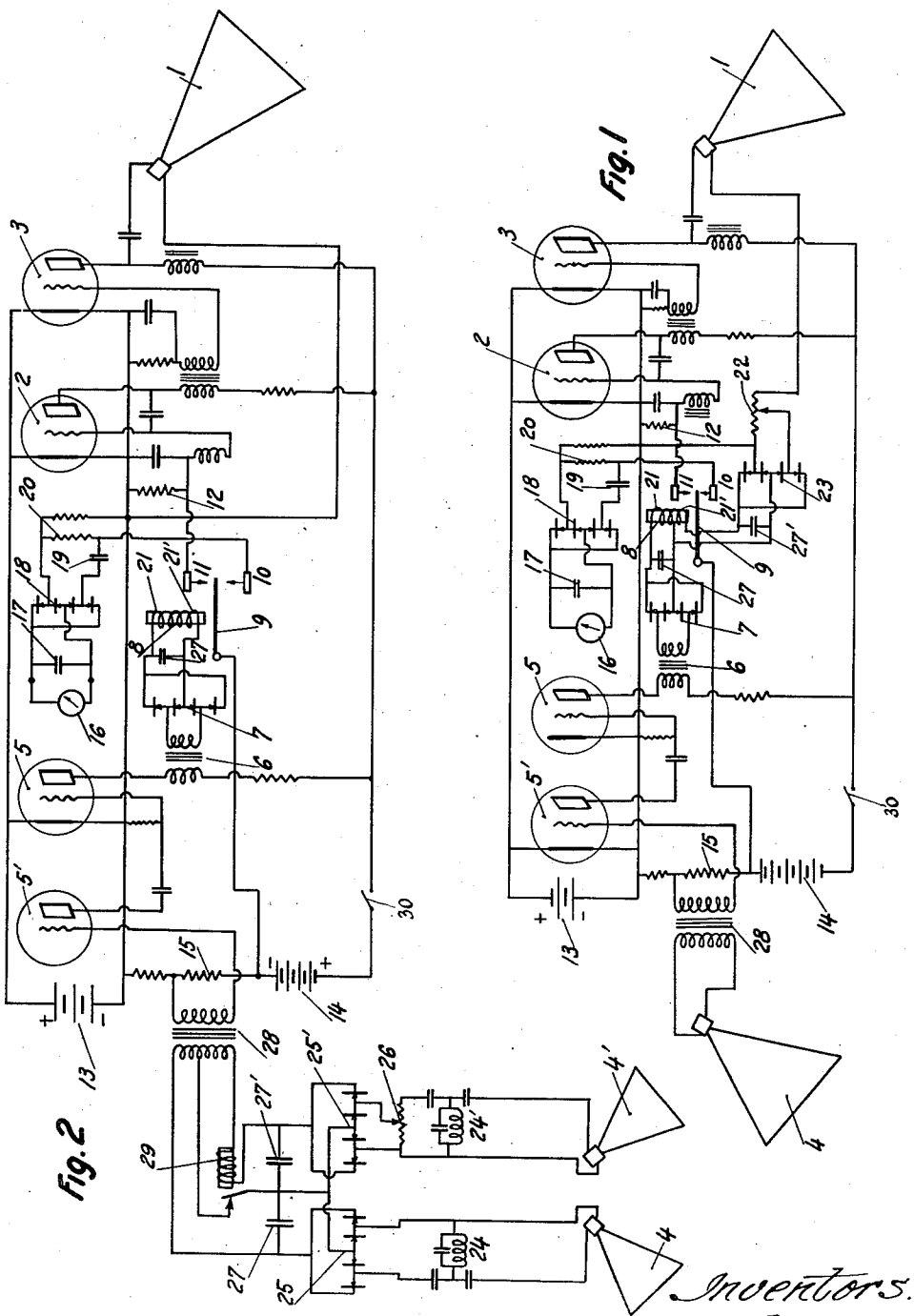

Fig. 1

Fig. 2

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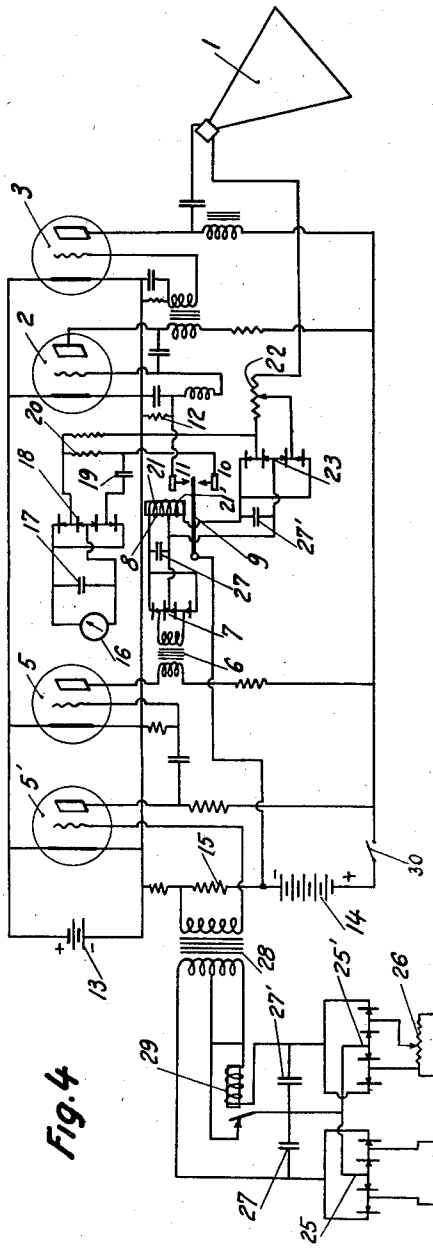

Fig. 4

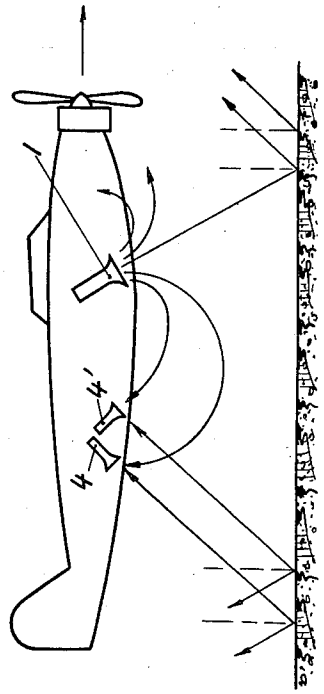

Fig. 3

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ELECTROACOUSTIC SOUNDING APPARATUS

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Application February 23, 1935, Serial No. 7,734
In France March 6, 1934

4 Claims. (Cl. 177—352)

This invention relates to improvements in and pertaining to electroacoustic sounding apparatus for aircraft, in which a sound or ultra sound wave emitted on board the airship by an emitter excited by an electric oscillator is received after being reflected from the ground by a microphone suitably located on board the airship, and a suitable apparatus for measuring the time taken by said wave to travel from the airship and back and therefrom the airship's altitude.

It is known that the range of said apparatus is generally reduced owing to the action on the receiving microphone of various parasite sounds, the most troublesome and strongest of these being such sound waves emitted by the emitter, which reach the receiving microphone directly without having been previously reflected from the ground.

In sounding apparatus of the type referred to, the action of such direct waves, the intensity of which is independent of the altitude of the sounding, may hinder or render completely impossible the taking of measurements. It has often been proposed for eliminating this difficulty to reduce either the output of the emitter or the sensitivity of the receiver, but this is naturally followed by the reduction of the range of the apparatus.

It has also been proposed to neutralize certain sound parasites, such as motor or propeller noises, by arranging on the airship one or several auxiliary microphones so located as to be acted upon by the parasites in the same manner as the principal microphone, and to be protected as completely as possible against the action of the waves reflected from the ground, the windings of the principal and the auxiliary microphones being connected in opposition. Under such circumstances when both microphones are equally sensitive to the parasite sounds and are located symmetrically to the source of the latter, these parasites may be theoretically neutralized if they act in phase on the two microphones. This device has, however, been found in practice to be extremely unsuitable due to the constant variations of the phase shift between the alternating currents generated by both microphones, said currents failing to neutralize one another. It is further very difficult to locate the principal and auxiliary microphones symmetrically with respect to all sources of parasite sounds, namely the motors, propellers and sound waves emitted by the emitter.

According to the present invention, the abovementioned difficulties are eliminated by generating a direct auxiliary current of a strength proportional to that of the emission, by detecting the current generated in the receiver and by neutralizing the direct auxiliary current, the component of the total current generated in said receiver due to the direct action of said emitter.

By way of example, three embodiments of our invention have been described with reference to the accompanying drawings, in which:

Figure 1 is a diagram of one embodiment of our invention in which the neutralizing energy is taken from the oscillator feeding the sound emitter.

Figure 2 is a diagram of another embodiment of our invention in which the neutralizing energy is generated by an auxiliary microphone.

Figure 3 indicates the arrangement on an airship of the emitter and receivers of our invention according to Figure 2; and

Figure 4 shows an embodiment of our invention in which the neutralizing energy is taken from the oscillator feeding the sound emitter, as shown in Figure 1, and also from an auxiliary microphone excited by the acoustic vibrations of the emitter according to Figure 2.

Although the direct wave neutralizing device, according to the present invention, may naturally be applied to any sounding devices of any known type utilizing acoustic or ultra acoustic waves, the invention has been described for sake of example as used in combination with a sounding apparatus, comprising an emitter of the acoustic type working by a sustained emission, a receiver adapted to receive the waves emitted by the emitter after their reflection from the ground and arranged in a manner to modify or completely interrupt the emission during the entire length of reception of the waves reflected from the ground, the frequency of such interruptions providing the measurement of the airship's altitude. The principal members of such apparatus are illustrated in the drawings.

The sounding apparatus of our invention comprises essentially an electromagnetic or a dynamic sound emitter 1 which is excited by an oscillating tube 2 by means of an output amplifying tube 3. An acoustic receiver 4 has, for example, an electromagnetic microphone adapted to receive, after its reflection from the ground, the sound waves issued by the emitter 1, is connected by means of suitably selected filters which with an amplifying tube 5. The output circuit or amplifying tube 5 is coupled, by means of a transformer 6 to a set of detecting valves 7, for example, metal oxide rectifiers, feeding a relay. The armature 9, which comprises a back contact 10 and a front contact 11, controls the bias of the grid of the oscillator 2, and prevents it from oscillating during the whole time of reception of the reflected wave

train. To that effect, the grid of said oscillator is connected, on the one hand, with a negative terminal of a heating battery 13, by means of the resistance 12, and on the other hand with the front contact 11 of the relay 8, the armature of which is connected with a negative terminal of a high tension battery 14, connected in its turn with a negative terminal of the heating battery 13 through the biasing resistance 15.

The values of the grid-biasing resistances 12 and 15, as well as those of the different grid-plate coupling members of the oscillator 2, are chosen in such a manner that the tube 2 starts oscillating as soon as the high tension battery 14 is connected to the plates of the tubes 2, 3 and 5 by means of the switch 30. The apparatus thus being set into operation, the emitter 1 begins to send a sustained wave toward the ground. As soon as the sustained wave arrives at the receiver 4, after reflection from the ground, a current generated by the receiver and amplified in the tubes 5 and 5' excites the relay 8 and brings the armature 9 on its front contact 11, thereby short-circuiting the grid-plate coupling members of the tube 2 by establishing a direct connection between the grid and the cathode and consequently interrupting the oscillations. As soon as the last wave emitted by the emitter 1 has reached the receiver 4 after reflection from the ground, the armature 9 comes back on contact 10 and the tube 2 is again set into oscillation, the emitter thus sending an interrupted or modulated sustained wave, the frequency of the interruptions or modulation being a function of the altitude of the airship.

For example, let h be the altitude of the airship and V the propagation velocity of the transmitted sound or ultra sound wave. When the apparatus is set into operation, a sustained sound or ultra sound wave will be emitted from the emitter on board the airship and will reach the ground and return it to the airship after a period of time equal to

$$\frac{2h}{V}$$

After the completely reflected wave train has been received, that is when the last sound or ultra sound oscillations transmitted by the emitter before the occurred interruption has reached the receiver, the influence of the receiver on the emitter ceases. The emitter will again be excited and will again transmit a sustained oscillation during a new period of time equal to

$$\frac{2h}{V}$$

after which the emission will be again cut off, etc. It is clear that under such circumstances the emission, as well as the current received will be modulated or periodically interrupted with a frequency equal to

$$\frac{V}{4h}$$

which consequently is inversely proportional to the altitude of the airship.

This modulation frequency is measured by means of a frequency meter, comprising, for example, a millimeter 16 receiving the discharges of a condenser 17 charged by a push pull set of rectifiers 18 fed from the back contact 10 of the relay 8 through a condenser 19 connected in parallel with a suitable load resistance 20 mounted in series in the output circuit of the tube 3. The push pull set of rectifiers 18 permits the rectification of both charging and discharging currents of the condenser 19 so as to charge and discharge the condenser 17 at a frequency double that of the minute wave modulation. The mean value of the current flowing through the ammeter 16 is proportional to the said modulated frequency, and the altitude of the airship will be directly indicated by the ammeter by providing the same with an inverse graduation.

According to our invention, the direct waves are neutralized as follows: the relay 8 comprises two windings 21 and 21', the first of which is being excited by the reception current as mentioned above, whereas through the second flows the neutralizing current, in an opposite direction to the former. This neutralizing current is derived from the plate current of the emitter amplifier 3 by means of a potentiometric resistance 22 connected in a series with the output circuit of said tube 3, and is detected in a set of valves 23 before being sent to the relay 8. The relay instead of comprising two separate windings, may be provided with a single winding with an intermediate tapping, as shown in the drawings.

The neutralizing current is regulated by means of the potentiometer 22 to a value in which the armature 9 of the relay 8 remains approximately in a state of indifferent equilibrium on its back contact 10, when the receiver 4 is actuated by direct waves alone, in the absence of waves reflected from the ground. In that case the arrival of a reflected wave, however weak it may be, immediately causes a swinging of the armature, the apparatus being thus very sensitive. In the intervals when the reception is interrupted by the reception of the reflected wave train, the neutralizing current is also automatically interrupted owing to the interruption of the oscillations generated by the tube 2.

In the embodiment illustrated in Figure 2, the device comprises beside the principal microphone 4, a single auxiliary microphone 4' located as shown in Figure 3 in a manner to be subjected solely to the action of the direct waves. For this purpose the auxiliary microphone is turned toward the front of the airship while the principal microphone 4 is turned toward the rear of the airship. The currents of both microphones are detected separately and then fed in opposition to the terminals of a winding, the resulting direct current being transmitted by means of a vibrating breaker to the input of a direct current amplifier. The drawings illustrate the microphone circuits which are provided with filters 24 and 24' adapted to attenuate the low frequency parasites (noises of motor, propeller, etc.) and are then connected with a set of rectifiers 25 and 25', this connection being performed for the auxiliary microphone by means of a regulator resistance 26. The rectifier sets 25 and 25' comprise in their output circuits parallel capacities 27 and 27' adapted to eliminate the alternating components of the rectified currents and feed in opposition the primary winding with intermediate tapping of a transformer 28. The return conductor, which is common to both the rectifier sets and connected to the intermediate tapping, comprises a vibrating breaker 29 of any suitable kind, for example, an electromagnetic breaker, so that the total reception and neutralization current issued from the primary winding of the transformer 28, as well as the differential flux of the transformer, are interrupted at the frequency of the breaker. An alternating voltage in the secondary winding results therefrom and

the voltage reaches the reception amplifier **5**. The construction of the apparatus is further shown in Figure 1 with the exception that the function of the neutralizing device **22** and **23** is performed by the auxiliary microphone **4'**.

It is, of course, understood that the second embodiment described may also be used for neutralizing the action of permanent parasites. However, if both waves and permanent parasites are to be neutralized, it will be difficult to set the microphones **4** and **4'** symmetrically with respect to both the parasite sources, namely the sound emitter, and the motor. In this case, both of the described embodiments will preferably be used simultaneously, that is, the device illustrated in Figure 2 being adapted to neutralize all the permanent parasites and as far as possible, the intermittent direct waves, whereas the device according to Figure 1 will be adapted to neutralize all such remaining direct waves which will not have undergone neutralization in the first instance.

The combination of the embodiments of Figure 1 and Figure 2 is shown in Figure 4 in which all the constructional elements are provided with the same reference characters and operate in the same manner as in Figures 1 and 2 so that they need not be further described.

It is equally understood that the device hereinbefore described may also be applied to sounding apparatus working on damped waves without exceeding the scope of the invention.

What we claim is:

1. In an airship sounding apparatus comprising an emitter of acoustic type adapted for sending sound waves toward the ground, a separate acoustic receiver converting into electrical energy the waves emitted by said emitter after their reflection from the ground, and means for measuring the time taken by said waves to reach the ground from the airship and to return, means for generating a direct auxiliary current of a strength proportional to that of the emission, means for detecting the current generated in the receiver, and means for neutralizing by said direct auxiliary current the component of the total current generated in said receiver due to the direct action of said emitter.

2. In an airship sounding apparatus comprising an electric oscillator, an emitter of acoustic type adapted for sending sound waves toward the ground, said emitter excited by said oscillator, a separate acoustic receiver converting into electrical energy the waves emitted by said emitter after their reflection from the ground, and means for measuring the time taken by said waves to reach the ground from the airship and to return, an adjustable potentiometric device mounted in the output circuit of said oscillator, means for detecting the voltage generated across said potentiometer, means for detecting the voltage generated in the receiver and means for neutralizing by said detected voltage led away from the oscillator the component of the total voltage generated in said receiver due to the direct action of the emitter.

3. In an airship sounding apparatus comprising an emitter of acoustic type adapted for sending sound waves toward the ground, a separate acoustic receiver converting into electrical energy the waves emitted by said emitter after their reflection from the ground and means for measuring the time taken by said waves to reach the ground from the airship and to return, an auxiliary acoustic receiver sensitive only to the direct action of the emitter, exclusive of the waves reflected from the ground, means for detecting the current generated in both said receivers, and means for neutralizing by the detected current of said auxiliary receiver the component of the total detected current generated in the principal receiver due to the direct action of the emitter on said principal receiver.

4. In an airship sounding apparatus comprising an electric oscillator, an emitter of acoustic type adapted for sending sound waves toward the ground, said emitter being excited by said oscillator, a separate acoustic receiver converting into electrical energy the waves emitted by said emitter after their reflection from the ground, and means for measuring the time taken by said waves to reach the ground from the airship and to return, an adjustable potentiometric device mounted in the output circuit of said oscillator to said emitter, means for regulating and for detecting the voltage generated across said potentiometer, means for detecting the current generated in the receiver, an auxiliary acoustic receiver sensitive to all permanent parasites, means for detecting the current generated in said auxiliary receiver, means for neutralizing by the detected current of said auxiliary receiver the components of the current generated in the principal receiver due to the action of all the permanent parasites, and means for neutralizing by the detected voltage generated across the potentiometer the component of the total voltage generated in the principal receiver due to the direct action of the emitter on said receiver.

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