(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 269 924 A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **87116690.6**

(22) Date of filing: **12.11.87**

(51) Int. Cl.⁴: **H01Q 1/12**

(30) Priority: **21.11.86 JP 278211/86**

(43) Date of publication of application: **08.06.88 Bulletin 88/23**

(84) Designated Contracting States: **DE FR GB IT NL**

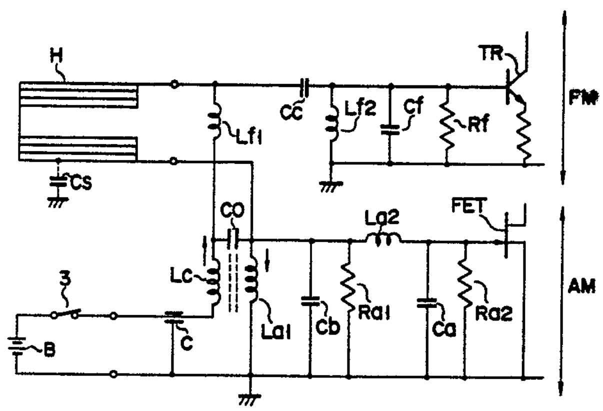
(71) Applicant: **HARADA INDUSTRY CO., LTD.**
17-13, 4-chome Minami Ohi
Shinagawa Tokyo(JP)

(72) Inventor: **Nakase, Kazuhiko**
1-22-17-506, Kitashinagawa Shinagawa-ku
Tokyo(JP)

(74) Representative: **Lins, Edgar, Dipl.-Phys. et al**
Patentanwälte Gramm + Lins
Theodor-Heuss-Strasse 2
D-3300 Braunschweig(DE)

(54) **Compensation amplifier for an automobile antenna.**

(57) A compensation amplifier for an automobile antenna utilizing, as an antenna element, a heating wire incorporated in an automobile rear window, for removing fog formed thereon, is connected between the heating wire and a radio receiver circuit, so as to compensate for a signal transmission loss. An AM band-pass filter coil (La1), a cancelling coil (Lc), and an FM band-pass filter coil (Lf1) are connected between the heating wire (H) and the battery (B). The FM band-pass filter coil (Lf1) and the AM band-pass filter coil (La1) are wound on a toroidal core with air gaps. A floating capacitor (Cs) is connected between the heating wire (H) and a ground potential terminal. The FM band-pass filter coil (Lf1) and floating capacitor (Cs) are used as a part of an input band-pass filter for an FM signal compensation circuit. The AM band-pass filter coil (La1), the floating capacitor (Cs), and an additional capacitor (Cb) are used as a part of an input band-pass filter for an AM signal compensation circuit.



F I G. 2

EP 0 269 924 A2

Compensation amplifier for an automobile antenna

The present invention relates to a compensation amplifier for an automobile antenna utilizing, as an antenna element, a heating wire incorporated in an automobile rear window, for removing fog formed thereon, which compensates for a loss in the power of signals transmitted between the antenna element and a radio receiver circuit.

In recent times, the heating wire for removing fog formed on the rear window of an automobile has come to be used also as an antenna element for a radio receiver. An example of this type of antenna is disclosed in Japanese Patent Disclosure (Kokai) No. 52-64,257 which corresponds to U.S. Patent No. 4,086,594 and U.K. Patent No. 1,520,030.

Fig. 1 shows this prior art. Heating wire H is incorporated in the rear window of an automobile. A blocking circuit made up of radio signal blocking coil 9 and choke coil 7 for suppressing interference are interposed between heating wire H and automobile battery B. The radio signal, such as a radio broadcasting signal, is picked up between heating wire H and blocking coil 9, and is amplified by preamplifier 13. The output signal from preamplifier 13 is supplied to a radio receiver circuit (not shown) via feeder line 2. Filtering capacitor 8, for removing noises from battery B, is connected between choke coil 7 and a ground potential terminal. Choke coil 7, blocking coil 9, filtering capacitor 8, and preamplifier 13 together form compensation amplifier 1. Heater on/off switch 3 is connected between choke coil 7 and battery B.

In this prior art, the inductance of blocking coil 9, is set at about 2 mH. According, the high frequency radio signal received by heating wire H, which is used as an antenna element, does not flow to the ground potential terminal but is instead transmitted tot he radio receiver circuit via preamplifier 13 and feeder line 2. Blocking coil 9 is wound on a pot core which does not have air gaps.

Since the direct current flowing through heating wire H is about 10A, the heating wire is required to be relatively thick in order to permit this large direct current to flow therethrough. Accordingly, the size of blocking coil 9 must be large enough to ensure that the necessary inductance can be obtained, which results in the undesirable enlargement of the overall size of compensation amplifier 1.

Further, in the above prior art, the pot core is used in order to render the overall size of the automobile antenna amplifier as small as possible. However, use of a pot core is expensive, and a surface of the pot core must be grinded to a mirror finish in order to eliminate air gaps. The necessity to do this increases the manufacturing cost of the automobile antenna.

The object of the present invention is to provide a compensation amplifier for an automobile antenna utilizing a heating wire as an antenna element, which is small in size and has a low manufacturing cost.

According to this invention, a compensation amplifier for an automobile antenna is provided, which comprises a band-pass filter coil interposed between a power source of a vehicle and a heating element serving also as an antenna element, the band-pass filter coil forming a band-pass filter with a floating capacitor connected between the heating element and a ground potential terminal, and a compensation circuit connected to the band-pass filter, for amplifying a signal output therefrom.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a prior compensation amplifier for an automobile antenna;

Fig. 2 is a circuit diagram of an embodiment of a compensation amplifier for an automobile antenna according to this invention;

Fig. 3 is an equivalent circuit diagram of a circuit for compensating an FM signal shown in Fig. 2;

Fig. 4 is an equivalent circuit diagram of a circuit for compensating an AM signal shown in Fig. 2; and

Figs. 5A and 5B show examples of a cancelling coil and an AM band-pass filter coil shown in Fig. 2.

Fig. 2 is a circuit diagram of an embodiment of the compensation amplifier for an automobile antenna according to this invention. This embodiment has coils interposed between heating wire H and DC (direct current) battery B, like the prior art. However, these coils are not used for blocking the high frequency signal; in other words, these coils are not used as choke coils. Instead, these coils are used as a part of a band-pass filter, and this is the difference between this invention and the prior art.

Band-pass filter coil La1 for an AM (amplitude-modulation) signal, cancelling coil Lc which cancels out DC magnetization caused by AM band-pass filter coil La1, and band-pass filter coil Lf1 for an FM (frequency modulation) signal are connected between heating wire H and battery B. FM band-pass filter coil Lf1 and AM band-pass filter coil La1 are wound on a toroidal core with air gaps. An inductance of AM band-pass filter coil La1 is set at

1 mH or less. Feed-through capacitor C for removing noises from battery B is interposed between cancelling coil Lc and battery B. Heater on/off switch 3 is connected between feed-through capacitor C and battery B. Floating capacitor Cs is connected between heating wire H and a ground potential terminal. Coupling capacitor Co is connected between cancelling coil Lc and AM band-pass filter coil La1.

The FM signal is supplied to an FM signal preamplifier including bipolar transistor TR through an FM signal compensation circuit including coupling capacitor Cc, coil Lf2, capacitor Cf, and resistor Rf. Band-pass filter coil Lf1 and floating capacitor Cs are used as a part of an input band-pass filter for an FM signal compensation circuit.

On the other hand, an AM signal is supplied to an AM signal preamplifier including field-effect transistor FET through an AM signal compensation circuit including additional capacitor Cb, coil La2, capacitor Ca, and resistors Ra1 and Ra2. Band-pass filter coil La1, floating capacitor Cs, and additional capacitor Cb are used as a part of an input band-pass filter for an AM signal compensation circuit. Additional capacitor Cb tunes a frequency of an AM signal.

The operation of the above embodiment will be described.

Fig. 3 shows an equivalent circuit diagram of the FM signal compensation circuit. In Fig. 3, Ra is an antenna resistor. This FM signal compensation circuit is a double tuning circuit and includes a primary tuning circuit and a secondary tuning circuit. The primary tuning circuit is made up of FM band-pass filter coil Lf1 of an air-core type and floating capacitor Cs. The secondary tuning circuit is made up of coil Lf2 and capacitor Cf.

In the prior art, since the radio signal flows to the ground potential terminal through floating capacitor Cs, floating capacitor Cs caused losses of the FM signal. However, in the present invention, since floating capacitor Cs is used as a part of the band-pass filter for tuning the FM signal, losses are not generated from floating capacitor Cs. Further, the gain of FM band can be increased by several dB's (Decibels) when compared with the prior art, due to the band-pass filter.

Fig. 4 shows an equivalent circuit diagram of the AM signal compensation circuit. The AM signal compensation circuit is a double tuning circuit and includes a primary tuning circuit and a secondary tuning circuit. The primary tuning circuit is a high-pass filter and, includes AM band-pass filter coil La1 which is of an air-core type, floating capacitor Cs, and tuning capacitor Cb. The secondary tuning circuit is a low-pass filter and includes coil La2 and capacitor Ca.

As seen from the above, since the floating capacitor Cs is used as a part of the band-pass filter for the AM band, losses are not generated from floating capacitor Cs. Further, the gain of the AM band can be increased by several dB's when compared with the prior art.

Figs. 5A and 5B show examples of windings of AM band-pass filter coil La1 and cancelling coil Lc. In the example of Fig. 5A, AM band-pass filter coil La1 and cancelling coil Lc are wound on ferrite core F as a bifilar winding. In the example of Fig. 5B, they are wound separately.

DC current from battery B flows through AM band-pass filter coil La1, causing DC magnetization and saturation in ferrite core F. Thus, the inductance of the coil is lowered below the desired level. In order to prevent this, cancelling coil Lc is wound such that the direction and the magnitude of the magnetic field of cancelling coil Lc are opposite to those of band-pass filter coil La1.

As mentioned above, according to this invention, band-pass filter coil La1 is used as a part of a band-pass filter and not as a choke coil. Accordingly, it does not matter that high frequency signal received by the heating wire, which is used as an antenna element, flows into the ground potential terminal. This feature significantly differentiates the present invention from the prior art. In the prior art, the inductance of coil 9 is set large so that the radio signal does not flow into the ground. When the coil is used as the coil alone, it works as a choke coil and blocks the signal to flow. When the coil is used as a tuning circuit with the capacitor, it permits to flow the signal of a tuned frequency range.

As can be understood from the above description, according to the present invention, it is not necessary to set the inductance value of the band-pass filter as high as in the prior art. As a result, a toroidal core rather than a pot core can be used in this invention. By using the toroidal core, the device can be manufactured at a lower cost than the prior art.

Further, since both AM and FM coils can be small in size, the overall size of the entire device can be also small.

In the above embodiment, the feed-through capacitor C inhibits the power supply noise caused by battery B from entering into the AM or FM compensation circuit. Additional capacitor Cb, together with band-pass filter coil La1, not only comprises a band-pass filter for an AM signal but also functions as a by-pass capacitor for an FM signal. Thus, a Stable tuning characteristic for an FM signal is obtainable without getting any influence from the AM compensation circuit.

The core used in the above embodiment for the windings of band-pass filter coil La1 and cancelling coil Lc is not limited to the torodidal core, and the pot core can be also used. With the use of the pot core, the size of the entire device can be further reduced.

As mentioned above, according to this invention, the overall size of the compensation amplifier for the automobile antenna can be reduced, and this is advantageous in view of the lower cost of manufacturing the same.

This invention is not limited to the above embodiment but can be changed or modified within the scope and spirit thereof.

Claims

1. A compensation amplifier for an automobile antenna utilizing, as an antenna element, a heating element for removing fog from an automobile rear window, said compensation amplifier characterized by comprising:

a band-pass filter coil (La1, Lf1) interposed between a power source (B) of a vehicle and said heating element (H), the band-pass filter coil (La1, Lf1) forming a band-pass filter circuit with a floating capacitor (Cs) connected between said heating element (H) and a ground potential terminal; and

compensation circuit means connected to said band-pass filter circuit and for amplifying a signal output from said band-pass filter circuit.

2. A compensation amplifier according to claim 1, characterized by further comprising a cancelling coil (Lc) for cancelling out a direct current magnetization which is caused by a direct current flowing through said band-pass filter coil (La1).

3. A compensation amplifier according to claim 2, characterized in that said band-pass filter coil (La1) and said cancelling coil (Lc) are wound on a ferrite core (F) as a bifilar winding.

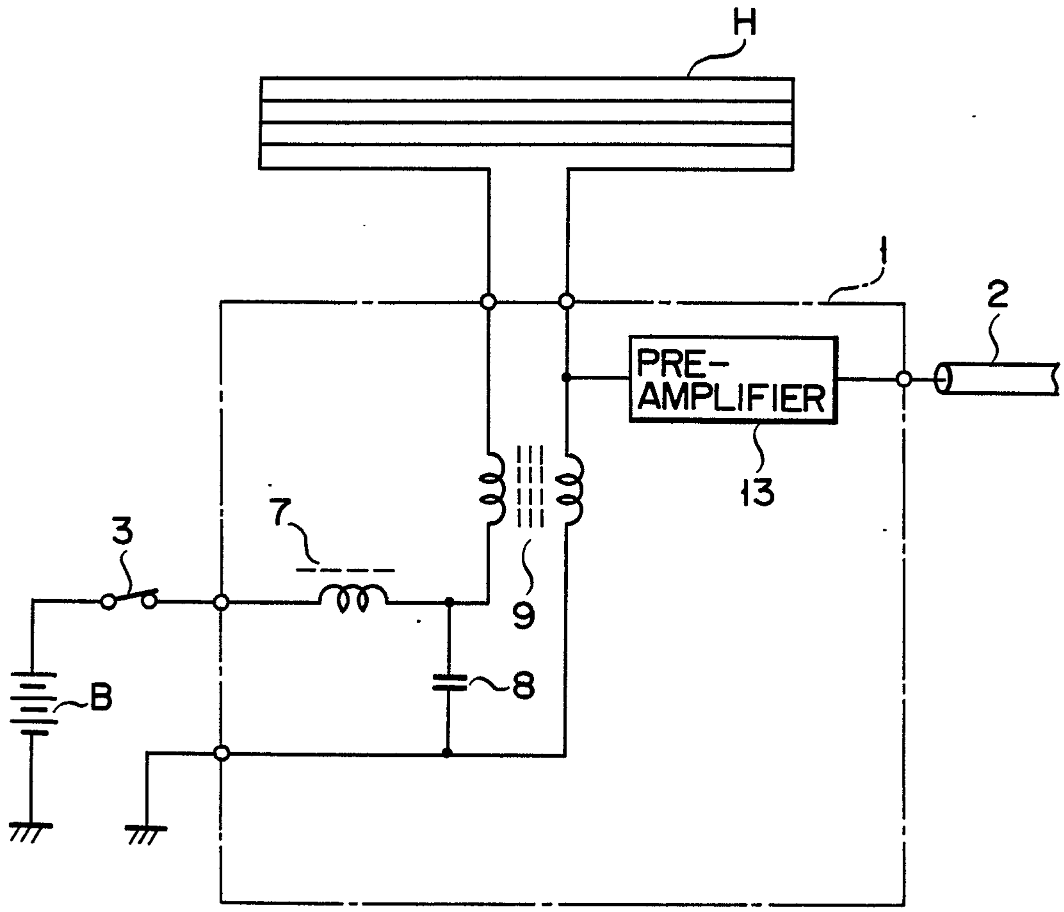
4. A compensation amplifier according to claim 2, characterized in that said band-pass filter coil (La1) and said cancelling coil (Lc) are wound on a ferrite core (F) separately.

5. A compensation amplifier according to claim 3 or 4, characterized in that said ferrite core (F) is a toroidal core with an air gap.

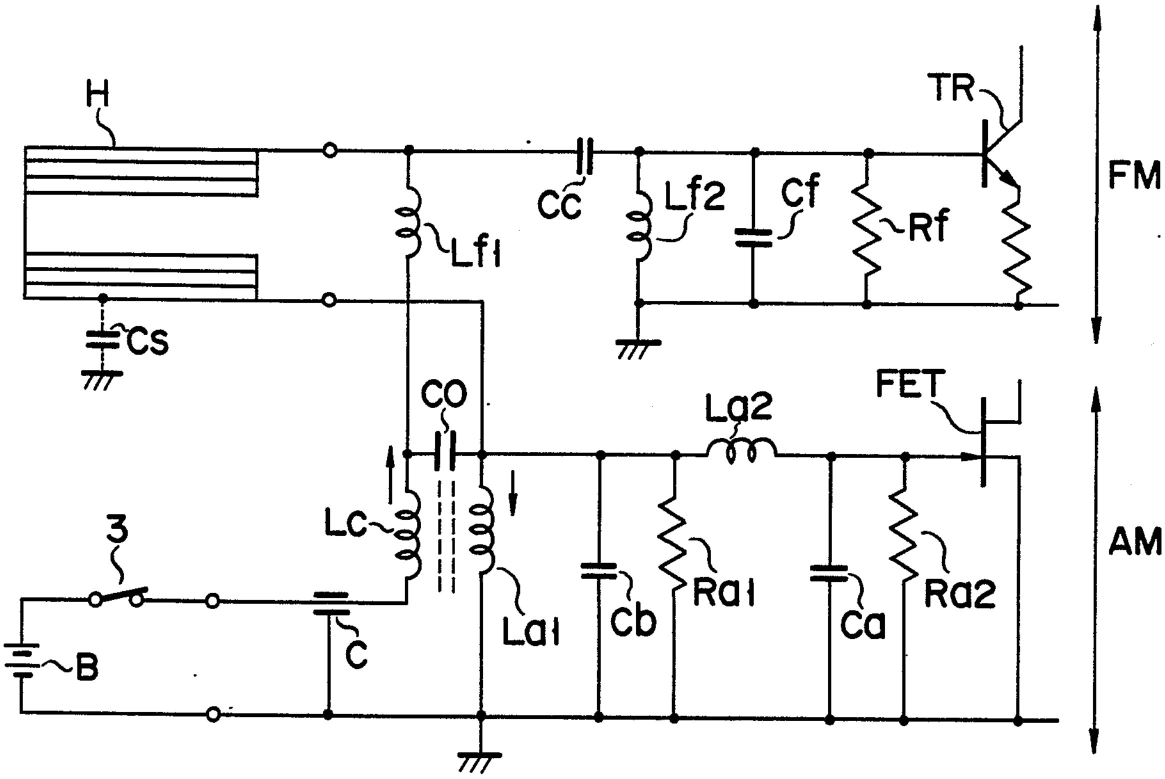
6. A compensation amplifier according to claim 2, characterized in that said band-pass filter coil (La1) and said cancelling coil (Lc) are connected to each other via a coupling capacitor (Co).

7. A compensation amplifier according to claim 1, characterized in that said band-pass filter circuit is a circuit for passing a frequency-modulation radio signal and characterized in that said band-pass filter circuit and said compensation circuit means form a double tuning circuit in which said band-pass filter circuit is a primary tuning circuit and said compensation circuit means is a secondary tuning circuit made up of a coil (Lf2) and a capacitor (cf).

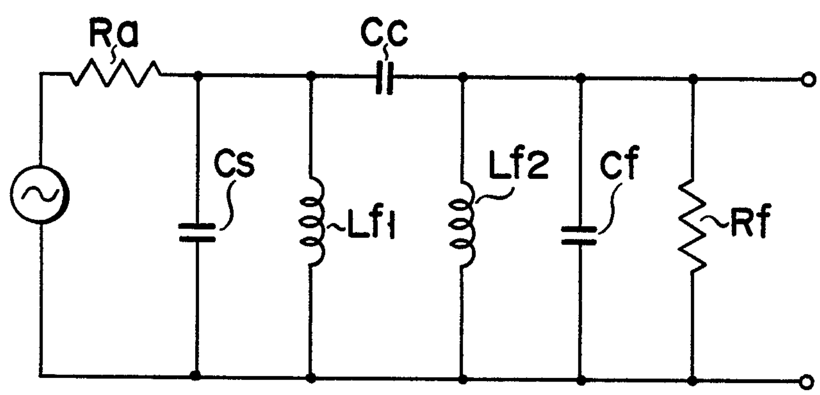
8. A compensation amplifier according to claim 1, characterized in that said band-pass filter circuit is a circuit for passing an amplitude-modulation radio signal and characterized in that said band-pass filter circuit and said compensation circuit means form a double tuning circuit in which said band-pass filter circuit and a tuning capacitor (Cb) form a high-pass filter as a primary tuning circuit and said compensation circuit means is a low-pass filter made up of a coil (La2) and a capacitor (Ca) as a secondary tuning circuit.



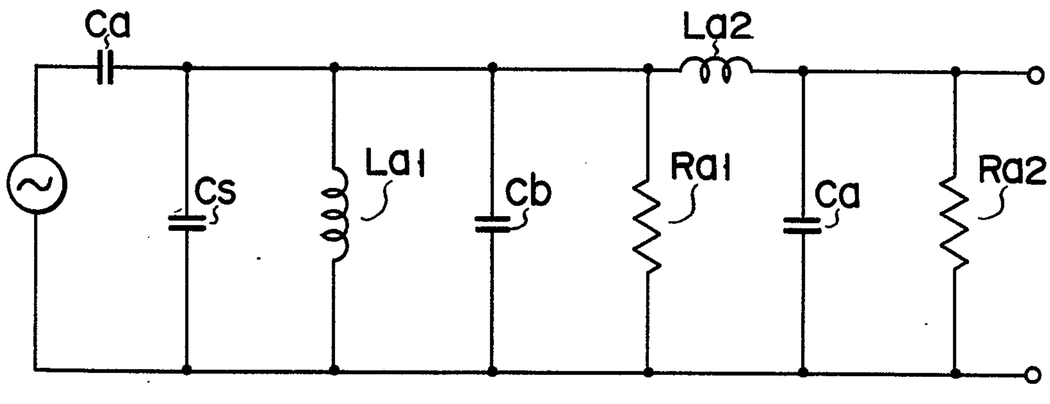
F I G. 1


H
TR
FM
Cc
Lf2
Cf
Rf
Lf1
Cs
CO
FET
La2
AM
3
Lc
La1
Cb
Ra1
Ca
Ra2
B
C

F I G. 2

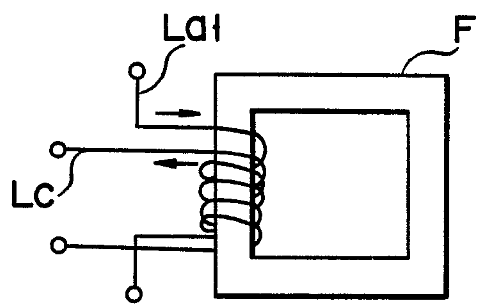

Ra
Cc
Cs
Lf1
Lf2
Cf
Rf

F I G. 3



F I G. 4

F I G. 5A



F I G. 5B