Nov. 18, 1941. W. H. NEWBOLD 2,262,956

ANTENNA COUPLING CIRCUITS

Filed May 1, 1940

Fig. 1.

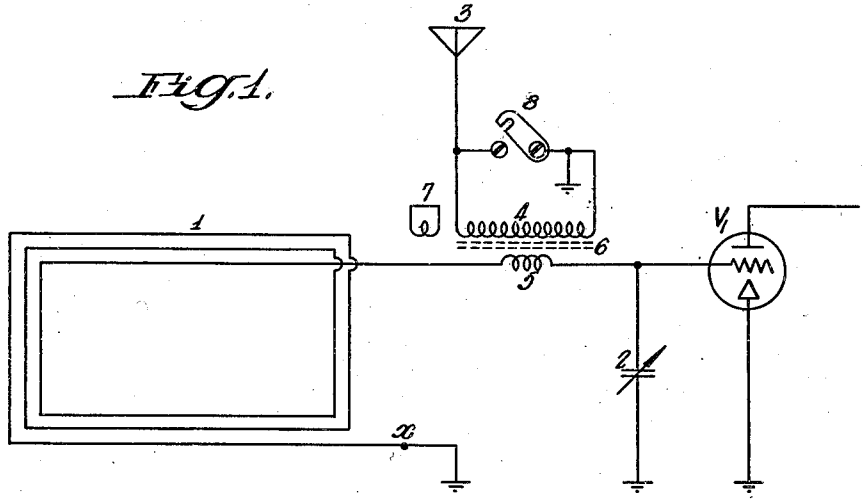
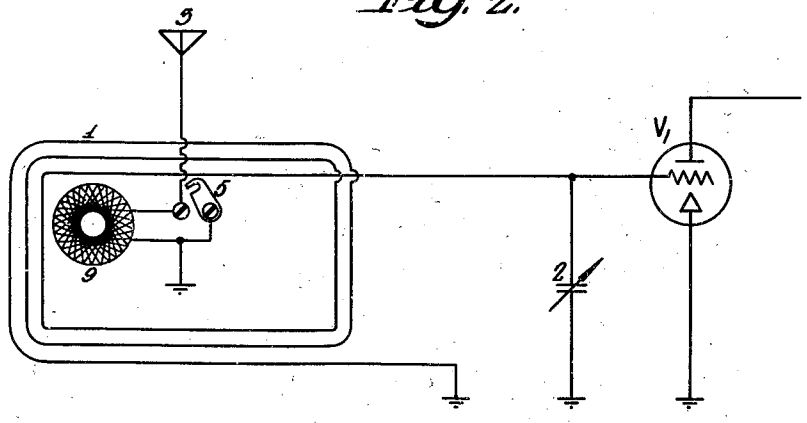


Fig. 2.



Inventor:-
William H. Newbold
by his Attorneys
Howson & Howson

Patented Nov. 18, 1941 2,262,956

UNITED STATES PATENT OFFICE

2,262,956

ANTENNA COUPLING CIRCUITS

William H. Newbold, Langhorne, Pa., assignor to Philco Radio and Television Corporation, Philadelphia, Pa., a corporation of Delaware

Application May 1, 1940, Serial No. 332,827

16 Claims. (Cl. 250—20)

This invention relates to antenna coupling circuits, and more particularly to means for coupling a conventional antenna to a radio receiver of the type whose input circuit comprises a tuned loop circuit.

Because of the unusual convenience and advantages afforded by receivers employing resonant loops, it has been found desirable in many instances to provide radio receivers with input circuits which consist of a tuned resonant loop circuit. However under certain conditions the loop may fail to provide an adequate signal, and for this reason it is desirable to adapt such receivers for optional operation from a more conventional antenna such as, for example, an elevated wire system. This is of particular importance where it may be necessary to operate the receiver in a shielded location.

In general it has been found desirable, when employing a conventional outside antenna with such receivers, to utilize the loop circuit as the receiver's tuned input circuit, and to couple the conventional antenna to the loop, rather than to provide a complete auxiliary tuned circuit for use only with the outside antenna. The latter practice would result not only in the duplication of elements, but would likewise complicate the switching required in changing from loop operation to conventional antenna operation.

Heretofore it has not been uncommon to couple the antenna into the loop by connecting the antenna to an intermediate tap on the loop winding, preferably through a small condenser, as shown in the copending application of David Grimes, Serial No. 277,276, filed June 3, 1939. Similarly it is known to couple the antenna to the loop inductively by means of a one- or two-turn winding wound over and parallel to the loop winding. It has been found, however, that receivers so coupled to conventional antennas yield a performance which is markedly inferior to that of receivers specifically designed to operate from such an antenna.

With the foregoing in mind, it is an important object of this invention to provide an antenna coupling circuit for a loop-equipped radio receiver which will enable the receiver to operate at high efficiency on either its loop or on a conventional antenna.

A further object of the invention is to provide a means for coupling a conventional antenna into a resonant loop through a high impedance primary winding.

Still another object of the invention is to combine the advantages of a high impedance antenna primary with a set designed for loop operation.

These and other objects, and the realization thereof by the present invention, will be fully understood by reference to the accompanying drawing, in which

Fig. 1 is a schematic diagram illustrating one method of coupling an antenna into a resonant loop circuit by means of a high impedance primary and a relatively low impedance secondary; and

Fig. 2 is a schematic diagram showing a modified form of the invention.

In each of the figures there is shown a tuned loop circuit comprising a loop winding 1 which may consist of one or more turns of a suitable conductor, and a variable tuning condenser 2 for tuning the loop to resonance with a desired radio frequency signal. The signal voltage output of the loop circuit may be connected to the input circuit of a vacuum tube V_1 from whence it may be supplied to any suitable signal utilization means. The antenna denoted by the reference numeral 3 may be any one of a wide variety of conventional systems, such as the usual elevated wire or flat top antenna.

Attention is now directed to Fig. 1 in which the antenna 3 is coupled into the resonant loop circuit (loop winding 1 and tuning condenser) by means of a transformer comprising a primary winding 4, and a secondary winding 5 serially connected in the resonant loop circuit. If desired, the transformer may be provided with a comminuted iron core 6. The primary winding 4 may advantageously be of high impedance and may be designed to resonate near the low frequency end of the desired frequency band when the antenna 3 is connected to the winding. Preferably the self-resonant frequency of the winding 4, with antenna attached, will lie outside of and below the band of frequencies which it is desired to receive.

In general the inductance of the secondary winding 5 should not be large compared to the inductance of the loop winding 1, and preferably the inductance of winding 5 is less than that of winding 1. The degree of coupling between the windings 4 and 5 will depend upon the relative values of inductances 1 and 5, but in general as the ratio of inductance 5 to inductance 1 decreases, the coupling between windings 4 and 5 should be increased. In this way, the optimum coupling between the antenna circuit 3, 4 and the resonant loop circuit 1, 5, 2 may be maintained

regardless of the specific inductances of the windings 1 and 5.

In practice, in order to decrease the gain of the circuit at frequencies below the desired frequency band, e. g. at the intermediate frequency of a superheterodyne receiver, it has been found desirable in some cases to provide a short circuited winding 7 on the coupling transformer. The winding 7, which may be of one turn, will have negligible effect on the signal transfer over the desired frequency band. Similarly in order to increase the gain at the high frequency end of the band, it may be desirable to wind the coils 4 and 5 in such a manner that the capacity coupling therebetween aids the inductive coupling. Such windings are well known in the art and hence require no description.

The winding 5 is preferably characterized by a high ratio of reactance to resistance, i. e., a high Q, where

$$Q=\frac{\omega L}{R}$$

the generally accepted figure of merit for coils. If the Q of coil 5 be made greater than the Q of the loop winding 1, the selectivity of the loop circuit may be increased over that obtaining without the winding 5. And if the Q of coil 5 be made greater than twice that of the loop 1, the sensitivity of the loop circuit may be made greater than it would be without the coil 5. The properties of loop circuits having serially inserted high-Q inductors are fully described and claimed in a copending application of William H. Grimditch, Serial No. 279,745, filed June 17, 1939.

In Fig. 1, the circuit is shown adapted for use with the antenna 3. If conventional loop reception is desired, this may be secured merely by disconnecting the antenna 3. With antenna 3 disconnected, it is possible that the winding 4 may be self-resonant at some point within the desired band of frequencies, and thus act as a load on the loop circuit 1, 5, 2. This may be avoided by providing a suitable means 8 for short-circuiting the winding 4 when loop antenna reception is desired. The effect of the short-circuited winding 4 on the loop circuit 1, 5, 2 will be practically negligible over the desired band of frequencies, and under these conditions the inductance 5 will contribute to the operation of the circuit in the manner described in the above mentioned copending application of William H. Grimditch.

Although the winding 5 is shown connected between the high potential end of the loop and the grid of tube V_1 it will be obvious that the winding might just as readily be connected between the low potential end of the loop and ground, by inserting it at the point marked X. In one embodiment of the latter connection, the following values of inductance gave very satisfactory results: primary winding 4, 1750 microhenrys; secondary winding 5, 16 microhenrys; loop winding 1, 150 microhenrys; mutual inductance between windings 4 and 5, 130 microhenrys.

Reference is now made to Fig. 2 in which there is illustrated a modification of the invention. In this embodiment, the antenna 3 is inductively coupled directly to the loop winding 1 by means of a suitable primary winding 9 positioned adjacent to a portion of the winding 1. By positioning the primary winding 9 in a corner of the loop winding as shown, sufficient coupling between the windings may readily be secured. The considerations governing the choice of inductance of the coil 9 are similar to those discussed hereinbefore with reference to the coil 4. Generally speaking the diameter of the coil 9 should be sufficiently great to permit the realization of the desired coupling between it and the loop winding 1. In one physical embodiment of the invention, the coil 9 was about 3 inches in diameter and had an inductance of approximately 2 millihenrys. The loop winding 1 was wound on a frame measuring about 8 by 14 inches. A suitable means 8 may be provided for short-circuiting the coil 9 when loop reception is desired.

While the invention has been described with particular reference to the embodiments of the drawing, it will be understood that the invention is capable of various forms of physical expression, and is, therefore, not to be limited to the specific disclosure, but only by the scope of the appended claims.

I claim:

1. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding and a tuning condenser connected to form a resonant loop tuning circuit capable of being tuned over a predetermined range of frequencies, an external antenna, a circuit including a high impedance primary winding inductively coupled to said tuning circuit, said primary winding being self-resonant near the low frequency end of the tuning range of said tuning circuit, and a connection from said antenna to said high impedance primary winding.

2. An antenna circuit for a radio receiver according to claim 1, characterized in that some capacitive coupling is additionally provided between said primary winding and said tuning circuit, said primary winding being wound in a direction such that the capacitively transferred signal aids the inductively transferred signal.

3. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding and a tuning condenser connected to form a resonant loop tuning circuit capable of being tuned over a predetermined range of frequencies, an external antenna, and a coil having a high inductance connected between said antenna and a point having a negligible radio frequency potential to ground, said coil together with said antenna forming a circuit which is self-resonant below the tuning range of said tuning circuit, the circuit comprising said antenna and said coil being inductively coupled to said tuning circuit.

4. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding, a coupling winding, and a tuning condenser connected to form a resonant loop tuning circuit capable of being tuned over a predetermined range of frequencies, an external antenna and a high impedance primary winding in circuit therewith, said last-named winding being inductively coupled to said coupling winding.

5. An antenna circuit as claimed in claim 4, characterized in that the inductance of said coupling winding is small compared to the inductance of said loop winding.

6. An antenna circuit as claimed in claim 1, comprising means for short circuiting said primary winding at will, whereby loop reception obtains over said predetermined range of fre-

quencies substantially without effect by said primary winding.

7. An antenna circuit as claimed in claim 4, wherein said coupling winding has a higher Q than said loop winding.

8. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding and a tuning condenser connected to form a resonant loop tuning circuit capable of being tuned over a predetermined band of frequencies, an antenna system including an external antenna, and a high inductance primary coil connected in said system, said primary coil being self resonant near the low frequency end of said band of frequencies, and being constructed and arranged to provide a predetermined coupling between said antenna system and said loop winding when said primary coil and said loop winding are intimately juxtaposed.

9. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding, a coupling winding, and a tuning condenser connected to form a resonant loop tuning circuit capable of being tuned over a predetermined range of frequencies, said coupling winding having an inductance which is small compared to the inductance of said loop winding, an external antenna and a high impedance primary winding in circuit therewith, said last-named winding being tightly coupled to said coupling winding.

10. An antenna circuit according to claim 9, characterized in that means are provided for short-circuiting said high impedance primary winding to provide pure loop reception substantially unaffected by said antenna or said high impedance primary.

11. An antenna system for a modulated-carrier signal receiver adapted to operate from a loop antenna or from an antenna-ground system comprising, a loop antenna adapted to be tuned over a frequency band, means for coupling said loop antenna to said receiver, an input circuit adapted to be connected to an antenna-ground system having capacitance, impedance means coupled to said loop and tunable by said antenna capacitance to resonance at a frequency near the lower end of said band, and means for selectively connecting said last-named means to said input circuit to couple said antenna-ground system through said loop antenna to said receiver.

12. An antenna system for a modulated-carrier signal receiver adapted to operate from a loop antenna or from an antenna-ground system comprising, a loop antenna adapted to be tuned over a frequency band, means for coupling said loop antenna to said receiver, an input circuit adapted to be connected to an antenna-ground system having capacitance, a primary circuit including a concentrated winding of cross-sectional area, perpendicular to its axis, small in comparison to that of said loop, said winding being positioned in inductive relation to said loop and being tunable by said antenna capacitance to resonance at a frequency near the lower end of said band, and means for selectively connecting said primary circuit to said input circuit to couple said antenna-ground system through said loop antenna to said receiver.

13. An antenna system for a modulated-carrier signal receiver adapted to operate from a loop antenna or from an antenna-ground system comprising, a loop antenna adapted to be tuned over a frequency band, means for coupling said loop antenna to said receiver, an input circuit adapted to be connected to an antenna-ground system having capacitance, a primary circuit including an inductor coupled to said loop, said primary circuit being tunable by said antenna capacitance to resonance at a frequency near the lower end of said band, and means for selectively connecting said primary circuit to said input circuit to couple said antenna-ground system through said loop antenna to said receiver.

14. An antenna circuit for a radio receiver, constructed and arranged to provide reception selectively from a loop or from an external antenna, comprising a loop winding and a tuning condenser connected in a closed resonant circuit capable of being tuned over a predetermined range of frequencies, an external antenna system, a primary circuit coil having a high inductance connected serially in said external antenna system, said coil together with said antenna system forming a circuit which is self-resonant near the low frequency end of said tuning range, and means including a winding whose inductance is small compared with the inductance of said primary circuit coil for inductively coupling said external antenna system to said closed resonant circuit.

15. In combination with a radio receiver, a resonant loop circuit comprising a loop winding and a tuning condenser, an external antenna, and means including a high impedance primary winding for inductively coupling said antenna to said resonant loop circuit.

16. In combination with a radio receiver, a resonant loop circuit comprising a loop winding and a tuning condenser, an external antenna, and means including a high impedance primary winding for inductively coupling said antenna to said resonant loop circuit, the resonant frequency of said high impedance primary winding with said external antenna attached being lower than the lowest frequency to which said winding can be tuned by said tuning condenser.

WILLIAM H. NEWBOLD.