July 13, 1937. R. M. SMITH 2,087,073

RADIO RECEIVER

Filed May 31, 1935 2 Sheets-Sheet 1

Fig. 1.

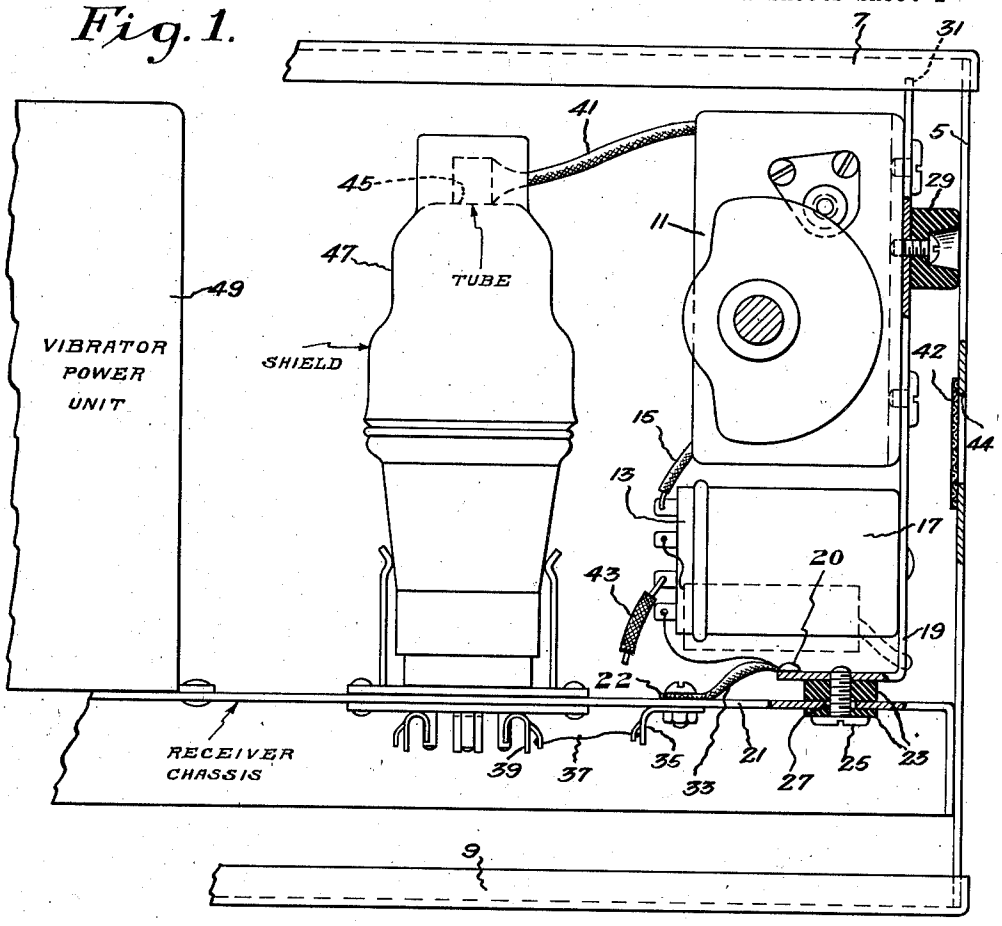


Fig. 2.

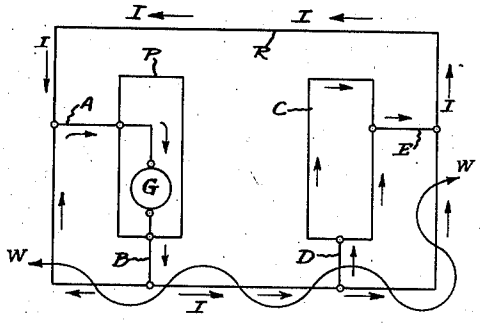
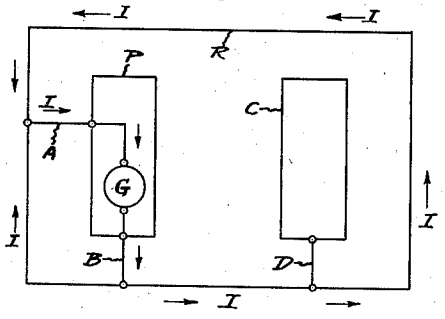


Fig. 3.



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Fig. 4.

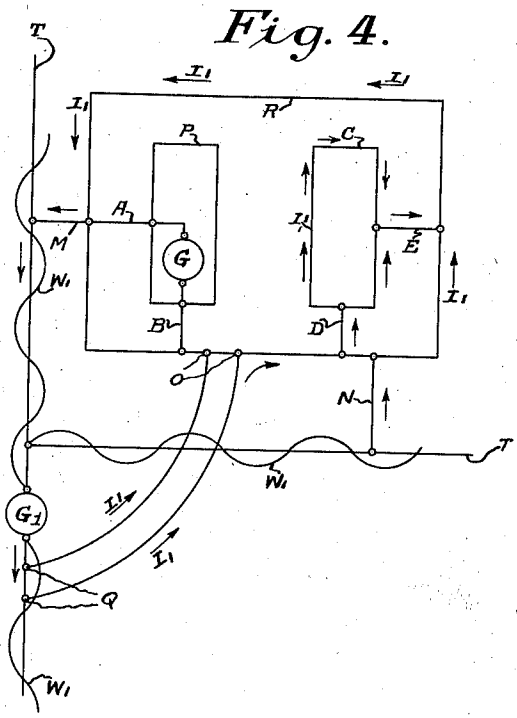


Fig. 5.

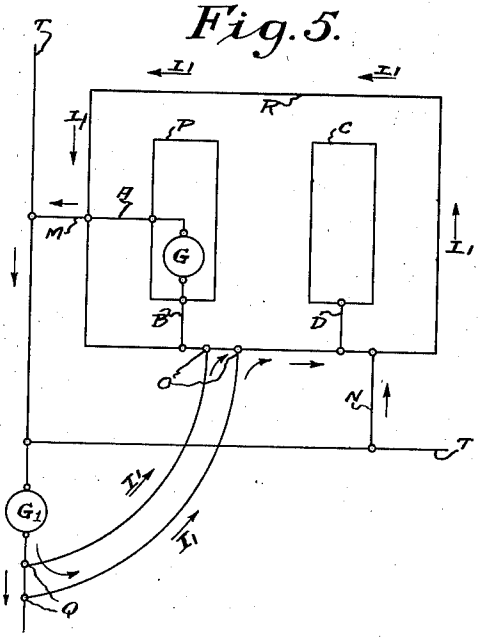
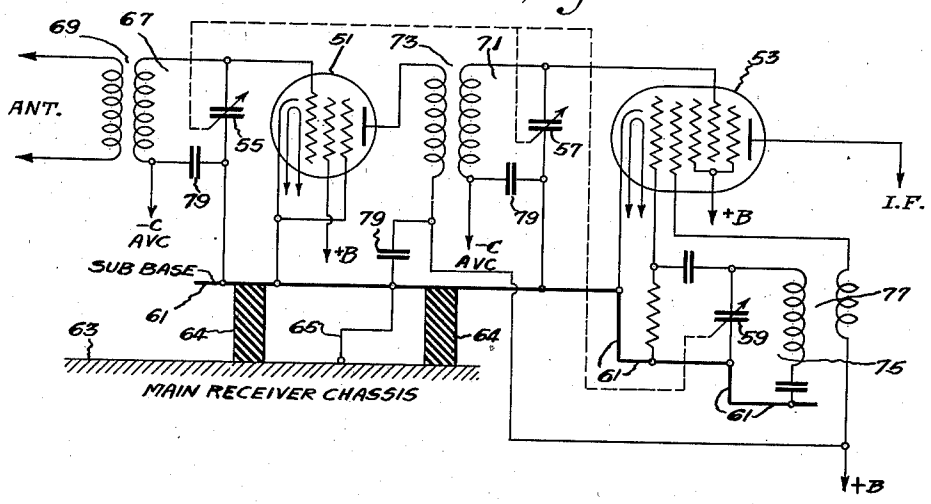


Fig. 6.



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UNITED STATES PATENT OFFICE

2,087,073

RADIO RECEIVER

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Application May 31, 1935, Serial No. 24,233

7 Claims. (Cl. 250—20)

The present invention relates to radio receivers, and more particularly to radio receivers for motor vehicles and the like which must operate in the presence of ignition and power supply short wave interference.

It is, therefore, an object of the present invention to provide a radio receiver wherein the effects of ignition and similar interference are materially reduced or prevented.

It is a further object of the present invention to provide an improved tuner arrangement for the high frequency portion of a radio receiving system whereby interference from circulating electrical current in the chassis is prevented from entering the high frequency circuits.

It is also a further and specific object of the present invention to provide a shielded radio receiver construction including a variable tuning high frequency selector means as a unit which is immune from electrical currents circulating in the chassis and from vibrational forces tending to disturb the tuning adjustment in a manner to produce acoustic feed back.

While the normal operating or generating frequency of the usual source of energy such as an ignition system or a vibratory radio power supply device, causing radio interference may be relatively low, connection leads and devices providing oscillatory circuits connected therewith may cause interference at very high frequencies. For example, a six cylinder car with the engine rotating at 2000 revolutions per minute may produce approximately 100 sparks per second. This 100 cycle frequency gives no appreciable direct disturbance in shielded radio apparatus. However, each high tension lead has inductance and capacity to the car body which makes it part of an oscillatory circuit. This oscillatory circuit radiates energy for each spark. The fundamental frequency depends upon the length of the ignition wires and their placement in relation to adjacent metallic objects. High tension currents from a coil radiate high frequency energy which is induced into the low tension light wires, the metallic car body and other metallic parts which are in close relationship to it.

For high frequency currents, the wave length may be only a few feet which may cause standing waves to appear in the car body. High frequency voltages may, therefore, be large at some points on the body and negligible at other points. At extremely high frequencies the voltages are very high and the highest interference area is found between 2 and 11 meters.

Energy radiated by wires and circulating currents in conducting material such as the casing of a receiver may enter the receiver through the antenna and lead in or through the control cables, power supply leads and other external connections in which voltages may be induced. Energy may also enter the receiver through openings in the receiver casing such as ventilating openings. Furthermore, energy may enter the receiver through circulating currents which are set up in the casing itself and, since the casing is normally grounded, particularly in a vehicle type of receiver, external leads through the casing provide a path for such circulating currents. Heretofore the entry of energy into a receiver through circulating currents and through openings has been disregarded as unimportant and apparently it has not been realized the extent to which such interference may become large in proportion to interference through other channels above mentioned.

It is, therefore, a still further object of this invention to provide a radio receiver having an outer casing with the inner elements thereof arranged and assembled to avoid the effects of circulating currents in the casing and to prevent noise voltages from being induced into the sensitive section of the receiver. At the same time, it is also provided that tuning system which is sensitive to vibration, may be protected therefrom.

It is also a further object of the present invention to provide a tuning means in a radio receiver which is substantially mechanically and electrically isolated both from circulating currents throughout the chassis and from vibration of the chassis.

It is a still further object of the invention to provide a receiver construction adapted for use in connection with a vibratory or other interference producing source of power therefore without introducing interference energy into the sensitive receiving circuits thereof from said source.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

In the drawings, Figure 1 is a view partly in section, of a portion of a radio receiver embodying the invention;

Figs. 2, 3, 4 and 5 are current flow diagrams illustrating the paths of various circulating currents and waves in a radio receiver when subject to interference energy, Figs. 3 and 5 illustrating

diagrammatically, the isolation afforded by the construction shown in Fig. 1, of the sensitive portions of the receiver from such interference; and

Fig. 6 is a schematic wiring diagram of a tuning system in a radio receiver also embodying the invention.

Referring to Fig. 1, 5 represents one side wall of a radio receiver casing having closed top and bottom members 7 and 9 respectively, all composed of conducting material such as steel, for example, in which is mounted, in spaced relation to the walls, high frequency receiving apparatus comprising a gang variable tuning condenser 11 and associated tuning inductances represented by the inductance 13, connected therewith by leads 15, and having individual metallic shield casings indicated at 17.

The tuning condenser 11 and the tuning inductances 13 are mounted on and electrically grounded to a separate base plate or sub-base 19 which is also spaced from the casing and from the receiver chassis or main base 31, by suitable spacing and supporting members providing flexible or resilient mechanical connection with the casing or chassis.

In the present example, such means comprises rubber washers 23 interposed between the sub-base 19 and the main chassis 21, through which a suitable clamping screw 25 engages the base for clamping the sub-base 19 to the chassis 21. An enlarged opening 27 in the chassis base is provided about the screw 25 so that the connection between the sub-base 19 and the chassis is insulated electrically. The connection between them is mechanical only with a large degree of flexibility afforded by the material of the washers, which is preferably soft rubber.

In the present example, the sub-base or plate 19 is bent at an angle as shown to permit the mounting of the condenser 11 and the inductances 13 in a vertical plane adjacent to the side wall 5 of the casing, and for that reason an additional spacing or buffer member of resilient material, such as rubber, is provided as indicated at 29, to engage the wall 5 thereby to space the plate 19 from the wall adjacent to the upper free end 31.

The condenser 11 is of the usual metallic shielded type, and circuit wiring is made directly from the condenser to the coils or inductances represented at 13, so that the high frequency tuning elements and their associated circuits are included on the mounting plate or sub-base 19, which in turn, is mechanically connected by resilient means to the chassis or casing, but not electrically. The tuning unit is, therefore, isolated from the remainder of the apparatus both electrically against circulating currents and mechanically against vibration tending to cause acoustic feedback through vibration of the condenser plates.

A single flexible electrical connection 33 is made to the radio chassis by a single wire or braid soldered or otherwise secured to the mounting plate 19 as indicated at 20 and connected to the radio chassis preferably at a single point of low potential with respect to circulating currents. The connection may be provided by a bolt 22 which is preferably provided with a terminal as indicated at 35 to which connection is made from the common ground point to other apparatus directly by wire 37 as indicated by the tube base terminal 39. The tube 45 is indicated in the drawings as being enclosed in a shield 47. The grid connection for the tube is provided through a lead 41 to the condenser 11. Other ungrounded circuit connections are made to the apparatus on the sub-base or mounting plate 19 as indicated by the lead 43.

Thus a one point ground is provided for the high frequency or tuned circuit portion of the receiver, thereby preventing undesirable circulating chassis currents from passing through any portion of the sensitive portions of the receiver. The spacing of the internal elements from the casing and the individual shielding of the elements further prevent inductive pickup from such currents.

A main source of energy and of vibration which may be included in the receiver casing, is represented by a vibrator power unit 49. As is well known, devices of this character include current interrupter means which may cause radio interference similar to that produced by the ignition system of the vehicle with which the receiver is usually associated. It will be seen that in Fig. 1, the radio frequency amplifier or high frequency portion of the receiver and, in particular, the tuned circuits are completely isolated as a unit electrically and mechanically from the vibrator power unit, so that disturbing currents may not flow from the latter in coupling relation to the elements of the tuning unit.

It will also be noted that a screen 42 of suitable woven metal wire is provided over an opening 44 representing any openings such as those for ventilation. This represents the treatment employed for all chassis and casing openings of any size to prevent coupling with the tuning unit by waves or electrostatic energy.

In Figs. 2, 3, 4, and 5 the outline chassis and receiver diagrams indicate the flow of chassis currents from an interference source of energy such as a vibrator power unit, or from an ignition source of interference and serve to illustrate how interference therefrom is prevented in a high frequency tuning unit when mounted as shown in Fig. 1.

Referring now to Fig. 2, a receiver, represented by the rectangular enclosure R, contains, among other things, a power supply unit P and a tuning unit C, the enclosing lines representing metallic walls providing a shield around each of the units named. The power unit P is known to be a source of interference, the generating element therein being indicated at G, which causes circulating currents I to flow as indicated by the arrows in the metallic members of the power unit as well as in the receiver chassis and the container for the tuning unit C. At ultra high frequencies the chassis members may approach a wave length in length or width. Therefore, it is possible to produce standing waves indicated at W or portions thereof in the receiver casing, for example.

Since the power unit is mounted on the receiver chassis, as indicated in Fig. 2, and is provided with input and output connections such as A and B, it is known to induce currents I in the receiver parts, chassis and casing as indicated by the arrows. The radio frequency or tuning unit C being the most sensitive portion of the receiver is most susceptible to these interfering currents and common practice has led to the connection arrangement shown, wherein the receiver tuning element is connected to the chassis or casing for the receiver at more than one point for mechanical or electrical reasons, as represented at D and E, for example. This causes a certain portion of

the interference current to be passed through the unit C as indicated by the arrows and results in what is commonly called static or interference.

Referring now to Fig. 3, it will be seen that the unit C is isolated from the casing R and connected therewith by a single connection D which is in accordance with the showing in Fig. 1. Since a complete circuit does not exist through the unit C, circulating currents I will not choose this path in their return circuit, thereby eliminating interference in the high frequency portion of the receiver.

Fig. 3, therefore, represents diagrammatically the arrangement of apparatus as shown in Fig. 1 wherein the parts P and C are spaced apart from each other and from the casing and in which the part C is electrically isolated from the remainder of the apparatus for the conduction of circulating currents.

Referring now to Fig. 4, the source of interference G and the power supply unit P, together with the high frequency tuning unit C, are the same as in Figs. 2 and 3 but with an additional source of interference G_1 which may represent an ignition system carried by the chassis of an automobile, indicated diagrammatically at T. The receiver R is assumed to be mounted on the frame or chassis T by connections M, N, O and Q providing electrical and mechanical connections therewith for the receiver.

The ignition system may produce interference currents I_1 as indicated by the arrows, or standing waves W_1, in addition to the currents and waves resulting from the interference source G as described in connection with Figs. 2 and 3 and omitted in the present figure for the sake of clearness. It will be seen that the current flow from the source G_1 is such that with connections, as shown, the interference currents will couple with the high frequency tuning portion C of the receiver thereby giving additional interference.

However, it will be seen that in case the high frequency tuning unit C is isolated electrically and mechanically and provided with a single connection D to the chassis or frame of the receiver as in Fig. 5, the external source of interference may not have coupling therewith, whereby the interference from that source is prevented.

The electrical circuits of a suitable tuning unit including the electric discharge amplifier devices which may be incorporated in a unit such as shown in Fig. 1 and diagrammatically indicated at C in the succeeding figures, a unit of this type is shown in Fig. 6 to which attention is now directed. This is a schematic circuit diagram of the radio frequency tuning portion of a superheterodyne receiver, for example, in which a tube **51** of the pentode type is utilized as a radio frequency amplifier and a second tube **53** is utilized as a combined detector and oscillator.

In the present example, a three unit tuning condenser is indicated by sections **55**, **57** and **59**, arranged to have a common grounded rotor connected as shown, to a sub-base or mounting plate indicated at **61**. The mounting plate is electrically isolated from the main receiver chassis represented at **63** by resilient mounting means **64** preferably of rubber, and is provided with a single flexible connection **65** to the main chassis.

All of the electrical circuits of the tuning unit normally connected directly with a receiver main chassis are connected, instead, to the sub-base or plate **61** as shown. Such circuits include the input circuit **67** for the radio frequency amplifier **51** comprising the portion **55** of the tuning condenser and the secondary of the input or antenna coupling transformer **69**, the tuned input circuit **71** for the combined detector oscillator **53** comprising the section **57** of the tuning condenser and the secondary of the coupling transformer **73**, and the oscillator tuned circuit **75** which includes the section **59** of the tuning condenser and the oscillator coupling coil **77**. It will be noted that all of said circuits are suitably by-passed to the plate or sub-base **61** through suitable by-pass condensers represented at **79**.

The high frequency tuning unit and the sensitive receiving circuits thereof are, therefore, connected to the sub-base **61** which is provided with a single connection to the main chassis for the supply of operating potentials, thereby prevented the flow of circulating currents through the tuner as a unit.

It has been found that this arrangement has materially aided in the prevention of noise in receivers for radio reception in the home and in particular in the automobile type of receiver which is subjected to both types of interference represented in the drawings, particularly in Figs. 4 and 5.

This chassis and circuit arrangement represents a portion of a general system for the prevention or elimination of interference from external and internal sources associated with a radio receiver and serves a definite purpose effectively and by means which may be applied in any receiver construction at low cost.

I claim as my invention:

1. A radio receiver comprising in combination, a metallic casing, a metallic base member mounted therein, radio receiving apparatus mounted thereon including a power supply unit, a high frequency tuning unit including a separate base plate mounted on said base member in spaced electrically insulated relation thereto and to the casing walls, said tuning unit further comprising a plurality of high frequency receiving circuits connected to said base plate and including tuning inductances and capacities, and means providing a single electrical connection between said base plate and said base member whereby said tuning unit is grounded thereto by a single electrical connection to prevent circulating currents flowing in said base member from being included in said base plate and tuning unit.

2. In a radio receiver, the combination of a chassis unit comprising a base member and an outer casing, a high frequency tuning unit sensitive to circulating currents in the base member and comprising a tuning device and a tuning inductance, a separate base and ground member for said device and inductance, means for resiliently mounting said second named base member in spaced electrically insulated relation to the first named member and casing, and means providing a single electrical ground connection from the high frequency tuning unit to the first named base member, whereby undesirable circulating currents in said base member are prevented from flowing in the high frequency unit and from coupling with the apparatus thereon and connected therewith.

3. In an automobile radio receiver having a power supply unit which operates to set up undesirable circulating currents, and a metallic chassis on which said power unit is mounted and in which said currents tend to flow, of means including a metallic base member for separately mounting the sensitive elements of said receiver including high frequency tuning circuits, insu-

lating means for resiliently supporting said base member in spaced relation to the chassis, means providing a single flexible electrical connection between said base member and the chassis at a predetermined point on said chassis, and means for grounding each of said circuits to said base member thereby to complete said circuits within the tuning unit to the exclusion of the receiver chassis and the circulating currents therein.

4. A radio receiving system including a plurality of tunable circuits and electric discharge amplifier devices connected therewith for amplifying and transforming signals received in said circuits, a metallic member providing a common supporting and grounding means for electrical elements included in said circuits and a common ground connection for said circuits, means for resiliently mounting said metallic member in insulated spaced relation to the remainder of said receiver, and means providing a single grounding connection thereto with the remainder of said receiver to prevent circulating currents flowing in the remainder of said receiver from being included in said metallic common supporting and grounding member and the circuits connected therewith.

5. A radio receiver comprising a metallic casing providing a shielded container, means providing a plurality of tuned high frequency receiving circuits therein and including a tuning condenser and a tuning inductance, means for electrically shielding said condenser and inductance, means providing a metallic base member for said condenser and inductance to which the shielding means are grounded by direct connection, a receiver chassis, resilient rubber mounting means for electrically and mechanically separating said base member and associated apparatus from the receiver chassis, power supply means carried by said chassis and connected therewith whereby circulating currents are caused to flow therefrom through the chassis, and means providing a single electrical connection between said base member and said chassis at a predetermined point to prevent the flow of said currents in said metallic base member.

6. A radio receiving system including a plurality of tunable circuits and electric discharge amplifier devices connected therewith for amplifying and transforming signals received in said circuits, a metallic member providing a common supporting and grounding means for electrical elements included in said circuits and a common ground connection for said circuits, means for mounting said metallic member in insulated spaced relation to the remainder of said receiver, and means providing a single grounding connection thereto with the remainder of said receiver to prevent circulating currents flowing in the remainder of said receiver from being included in said metallic common supporting and grounding member and the circuits connected therewith.

7. A radio receiving system including a plurality of tunable circuits and electric discharge amplifier devices connected therewith for amplifying and transforming signals received in said circuits, a metallic member providing a common supporting and grounding means for electrical elements included in said circuits and a common ground connection for said circuits, means for mounting said metallic member in insulated spaced relation to the remainder of said receiver, and means providing effectively a single grounding connection thereto with the remainder of said receiver to prevent circulating currents flowing in the remainder of said receiver from being included in said metallic common supporting and grounding member and the circuits connected therewith.

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