Aug. 8, 1944. F. F. SHOUP 2,355,182

NOISE REDUCTION SYSTEM

Filed June 27, 1941

Fig. 1.

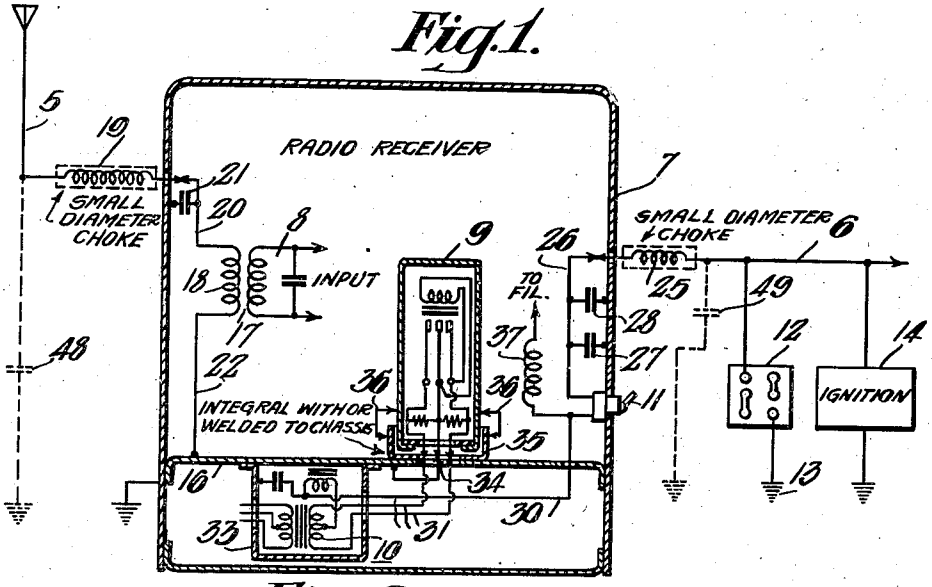


Fig. 2.

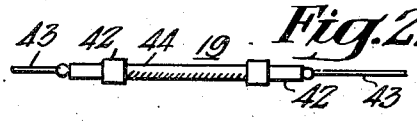


Fig. 4.

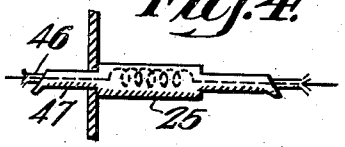
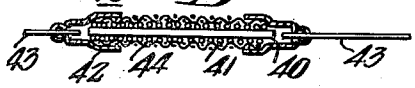


Fig. 3.



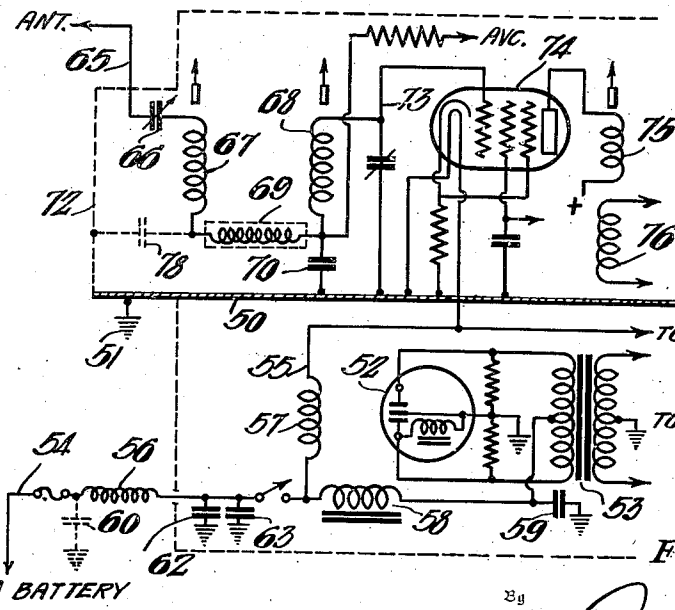


Fig. 5.

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NOISE REDUCTION SYSTEM

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Application June 27, 1941, Serial No. 400,003

6 Claims. (Cl. 250—20.5)

This invention relates to noise reduction systems for radio signal amplifiers and the like, which derive operating current from vibrator power supply units, as automobile receivers, for example, and has for its primary object to provide an improved and simplified form, and distribution, of circuits elements for materially reducing the noise pickup in such apparatus, without materially increasing the cost of construction.

It is a further object of this invention, to provide an improved form of high frequency choke coil and circuit distribution therefor in connection with automobile radio receiver signal and current supply circuits, which are effective to minimize noise pickup from the vibratory power supply system thereof.

It is a still further object of this invention, to provide an improved arrangement in connection with the power supply system for a radio receiver of the character referred to, for further effecting noise reduction in the receiving circuits from the vibratory power source.

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

In the drawing,

Figure 1 is a schematic circuit diagram of the signal and power supply system of a radio receiver embodying the invention;

Figures 2 and 3 are external and cross sectional views, respectively, and substantially full size, of a noise reduction element employed in the system of Fig. 1;

Figure 4 is an external view, substantially full size, of another noise reduction element also employed in the system of Fig. 1; and

Figure 5 is a schematic circuit diagram of a modification of the circuit of Fig. 1, showing the signal and power supply circuits of an automobile radio receiver embodying the invention.

Referring to Figures 1 to 4, inclusive, 5 is an antenna connection and 6 is a battery connection for supplying signal and power, respectively, to a shielded radio receiver 7 comprising a signal input circuit 8, a vibratory power supply device 9, a power transformer 10 and a power switch 11.

The lead 6 may be considered to represent the high side of the battery supply circuit for an automobile or other mobile device and is supplied with energy from a battery indicated at 12, having one terminal connected with the lead 6, while the opposite terminal is connected to ground or chassis, as indicated at 13. The system of the present example, also includes the usual circuits for the ignition system indicated at 14. The latter imparts to the lead 6 a noise signal which must be eliminated from the receiving circuits. Likewise, the vibrator 9 imparts a noise signal to the distributed wiring of the vehicle and to the receiving circuits, unless precautions are taken to prevent such pickup.

As is the usual practice, the receiver system is included in a shield case as indicated, having a metallic chassis member 16 with the vibrator 9 mounted on one side thereof, while the power transformer 10 is mounted on the opposite side as shown. Above the chassis are the input circuit 8, and other circuits of the receiving system which are not shown for the sake of simplifying the drawing.

The signal input circuit 8 is coupled through a transformer 17 having a primary winding 18 in the antenna circuit 5 which is extended from the exterior of the receiver to the interior through a choke coil or inductance indicated at 19 and a supply lead 20 which is bypassed to chassis by suitable means, such as a capacitor 21. The circuit is completed through a lead 22 connected with the chassis or ground, as indicated. The choke coil 19 is close to the casing substantially at the entrance point of the antenna lead.

On the power supply side of the receiver, a similar choke coil indicated at 25 is provided directly externally of the shield casing 7 and connected with an interior supply lead 26 which is also bypassed to chassis or ground as indicated by the parallel connected capacitors 27 and 28, the latter being a high frequency bypass for the former. The switch 11 is included in the lead 26 which provides a connection through a lead 30 with the power transformer 10. Leads 31 connect the transformer with the vibrator, as indicated, which serves to interrupt the primary current with a full wave action in the present example. As the form of vibrator and transformer do not concern the invention, further description is believed to be unnecessary.

However, it will be noted that the transformer is included in a metallic shield casing 33 and that the vibrator, as in the usual case, is likewise included in a metallic shield casing. While the power transformer 10 is mounted below the chassis 16 and therefore effectively decoupled both electrostatically and electromagnetically from the input and other circuits of the receiver, the vibrator 9 is mounted above the chassis for convenience in servicing and is removable from the apparatus by the usual contact means indicated at 34. In engaging the contacts, the vi-

brator is caused to seat within a metallic ring member or short-circuited conductive turn **35** which overlaps the joint between the vibrator and chassis sufficiently to prevent magnetic leakage from the vibrator circuits to the input circuit **8** and other circuits (not shown) of the receiving system.

It has been found that this ring must be substantially integral with or welded or otherwise secured to the chassis at a plurality of points in order that the noise pickup from the vibrator may effectively be eliminated.

The casing of the vibrator **9** is grounded to the cup or ring **35** at one or more points, as indicated by the connections **36** to provide electrostatic shielding. This may be provided by any suitable means providing connections as shown between the vibrator casing and the ring **35** and at least one such connection should be provided in each case. It will also be noted that the filament connection for the receiving system is taken from the lead **30** through a suitable high frequency choke coil **37**. This may be of any suitable construction provided it is relatively small.

It has also been found that the choke coils **19** and **25** must be of relatively small diameter with respect to their length, having substantially the shape and size shown in Figs. 2, 3 and 4.

As shown in Fig. 3, the choke coil may comprise a flexible core **40** of insulating material and of substantially minimum diameter for a given wire size for the coil or winding **41** thereon. The latter comprises a single layer solenoid of insulated conductor with the ends connected to metallic end ferrules **42** which in turn are connected with flexible soldering leads or wire **43** at the ends of the unit. The winding may comprise several hundred turns of No. 40, B. & S. gauge, enameled copper wire, for example, and is covered preferably with a flexible insulating braid, indicated at **44**.

In the case of the coil **25**, it is similarly constructed of insulated wire **46** and is covered by an outer insulating braid **47**. It will be noted that this wire is relatively heavy for carrying the battery current to the vibrator and other circuits of the receiver. By way of example, No. 18 B. and S. gauge enameled wire had been used and may comprise a plurality of turns, of the order of **20**, for example, in present case.

This system and type of choke coil serves to minimize undesired electrical noise impulses caused by the ignition system and vibrator **9** in the supply circuits entering the sensitive receiving circuits in a more effective manner than any other known arrangement. It has made possible a greater sensitivity with substantially no noise interference in present commercial installations. Since the coils are relatively small, they may readily be inserted in the supply circuits at any desired points. As shown, these coils are preferably external to the receiver and shield housing at the points of entry of the supply leads thereto. In this case, the capacitance of the connectors and cable clamps with the inductances **19** and **25**, provide effective filters without additional capacitors, which resonate in the range of noise pulses, for example, between 7.5 and 75 m. c. The external capacitance is indicated in dotted lines in Fig. 1 at **48** and **49** and may be of the order of 40 mmfd. in some cases.

Although filter choke coils have been used heretofore for the reduction of undesired signal impulses, it has been found that coils of unusually small diameter relative to the length, for example, having a diameter which is a small fractional part of an inch and a length to diameter ratio of greater than 10:1, are much more effective in limiting electrical noise impulses than choke coils having a more conventional design and size.

As described, these coils are made preferably in the form of flexible wire-wound elongated units whereby they are readily manufactured in much the same manner as resistors, and as easily installed in circuit, while the construction is of the same relative low cost. Such coils in actual practice range in length from one inch to two-and-one-half inches depending upon the extent or amplitude of the noise impulses to be eliminated.

The diameter of the internal core here considered, is of the order of one-sixteenth inch when starting the winding process, and depending upon the nature of the core material, this may be reduced in various degrees when the coil is completed. The inner core may be a braid or cord of any suitable insulating material and the outer cover may be of any suitable insulating or protecting material such as cotton braid, insulated metallic shielding, molded rubber or so-called "spaghetti" insulation.

It has been customary to ground vibrators and casings with a spring-fingered cup. This, however, has proved to be not effective in preventing electrical disturbances from entering the receiving circuits. The use of a short circuited ring shield about the vibrator base substantially integral with the chassis minimizes noise pickup from the sources referred to, even though slightly spaced about the vibrator base. The cup or ring thus secured to or formed with the chassis, becomes a grounded short-circuited turn or winding for the electromagnetic field of the vibrator where the electrical connections are made below the casing. In certain apparatus, this ring may be formed from the chassis material. In any case there must be no magnetic flux leakage between the ring and the chassis about the power supply connection to the vibrator device.

Referring now to Fig. 5, the chassis of a radio receiver is indicated at **50** and is connected to ground as indicated at **51**. This serves as a shield between radio receiving circuits above and power supply circuits below, the latter comprising a vibrator device **52**, the power transformer **53** and "A" battery supply lead **54** connected to the transformer and to a filament circuit **55** through an external input choke coil **56** and suitable internal choke coils indicated at **57** and **58**, the latter being an iron core choke coil, provided with a bypass capacitor **59** to ground.

The distributed capacity of the supply lead external to the receiver is indicated at **60**. With the choke coil **56** this provides an effective external filter for removing from the receiving circuits, radiation back from the "A" battery lead **54** to the vehicle or other power supply means with which the system is used. Internal bypass capacitors are indicated at **62** and **63** providing low and high frequency bypass means for the "A" battery supply.

Above the chassis, the antenna lead, indicated at **65**, is connected through a coupling capacitor **66** with an input primary winding **67** coupled to a secondary winding **68** connected through a choke coil **69** and a bypass capacitor **70** with ground. The choke coil **69** may be located internally of the receiver shield casing indicated by the dotted outline **72**, without interfering with the operation of the noise reduction system. This is for the reason that the choke coil is of such

relatively small diameter that it sets up a relatively small field for coupling with other elements of the receiver, such as the input circuit indicated at 73 for the first amplifier tube 74 and the output circuits 75 and 76.

The distributed capacity of the antenna input lead is indicated at 78. With the choke coil 69, this provides a filter for the undesired ignition and other noise impulses received on the antenna lead. The operation of the circuit is otherwise the same as that described in connection with Fig. 1, and the choke coils 69 and 56 correspond respectively with the construction shown in Figs. 2–3 and 4.

While the invention has been described in connection with automobile radio receiving systems, it is not limited thereto, but may be provided in connection with any receiving system having noise impulse sources associated therewith such as vibratory power supply and ignition circuits.

I claim as my invention:

1. The combination with shielded signal amplifying apparatus, of external signal and power supply leads extending into said apparatus, flexible inductive filter elements adjacent to the points of entry connected serially in said first and second named leads, providing with the distributed capacity thereof with respect to said shield and said power supply and leads high frequency noise filters for said leads, said inductive elements each comprising a single layer conductive winding having an internal diameter of the order of one-sixteenth of an inch, and having a length at least of the order of one inch.

2. In a radio receiving system, the combination with a signal receiver having a shield casing, a chassis and signal and power supply leads for said receiver, of an unshielded elongated small diameter flexible choke coil in each of said leads external of and adjacent to said casing providing filtering elements for said leads to prevent the entry of high frequency disturbances into said receiver, the internal diameter of said choke coils being of the order of a small fractional part of an inch and substantially a minimum consistent with effecting a single layer winding with a relatively small wire gauge, and having a length to diameter ratio greater than 10:1, and capacity means for causing said choke coils to resonate in a relatively high frequency disturbance range.

3. The combination with signal amplifying apparatus, of a supply lead therefor, a high frequency noise filter in said lead adjacent to said apparatus comprising the distributed capacity of said lead and an unshielded elongated single layer flexible inductance winding comprising a plurality of conductive turns of relatively small gauge wire having an internal diameter of the order of one-sixteenth of an inch and a length of the order of at least one inch.

4. A choke coil element for a high frequency noise filter system, comprising an unshielded elongated flexible inductance winding of relatively small gauge wire having an internal diameter of the order of a small fractional part of an inch, and a length to diameter ratio in excess of 10:1.

5. A choke coil element for a high frequency noise filter system, comprising an unshielded elongated flexible inductance winding of relatively small gauge wire having an internal diameter of the order of a small fractional part of an inch, and a length to diameter ratio in excess of 10:1, and means providing spaced terminal ends for said winding and a protective covering for said winding interposed between said terminal ends.

6. A choke coil element for a high frequency noise filter system, comprising an unshielded elongated inductance winding of relatively small gauge wire having an internal diameter of the order of a small fractional part of an inch, and a length to diameter ratio in excess of 10:1, means providing a flexible core element for said winding, a pair of spaced terminal ends for said choke coil element to which said winding is connected, and means providing a protective covering for said winding between said terminal ends.

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