March 3, 1936. W. P. LEAR ET AL 2,032,424

POTENTIAL CHANGER

Filed Sept. 27, 1932 4 Sheets-Sheet 1

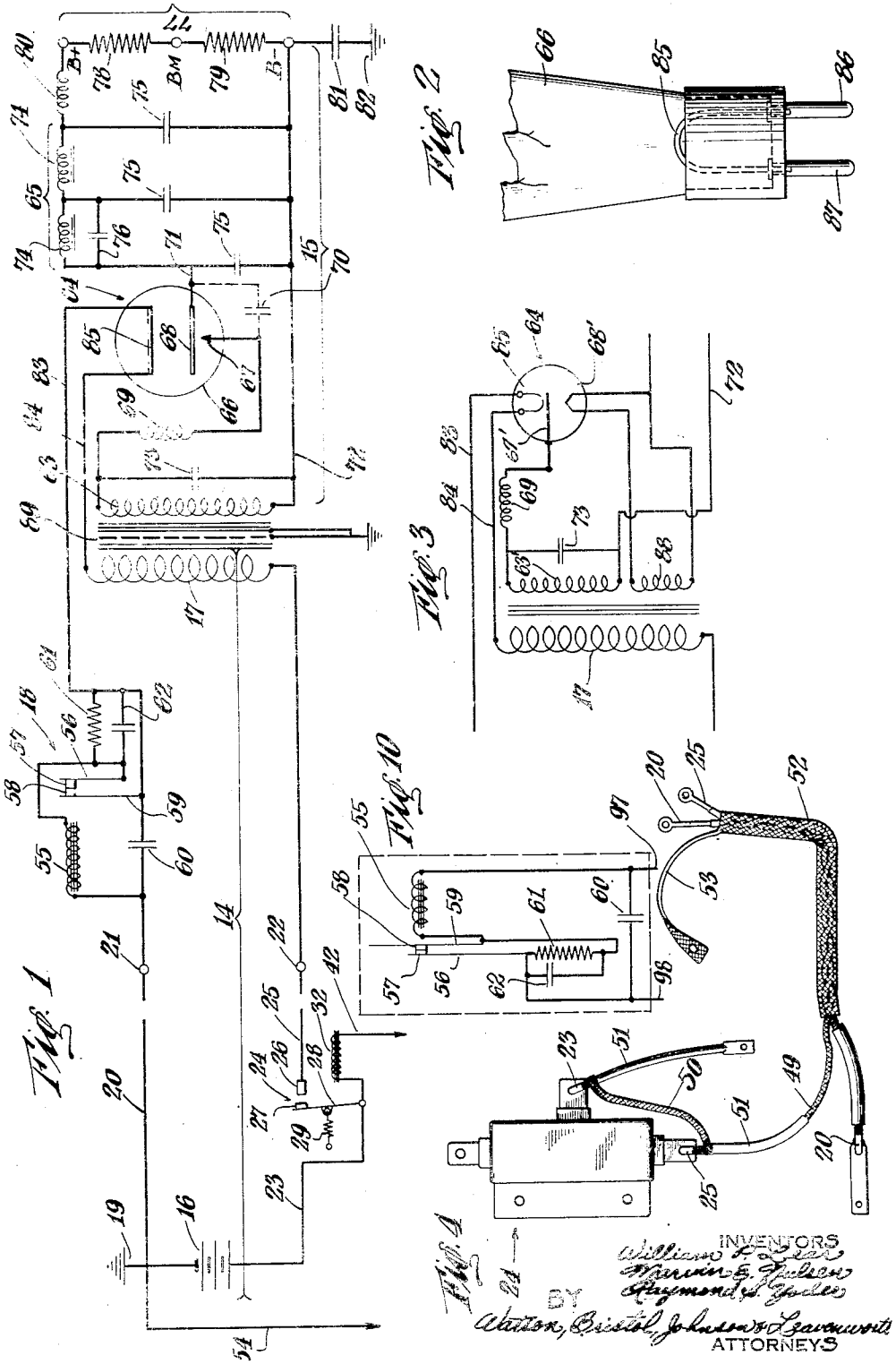


Fig. 1

Fig. 2

Fig. 3

Fig. 10

Fig. 4

INVENTORS
William P. Lear
Marvin E. Nelsen
Raymond S. Ydstie
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

March 3, 1936. W. P. LEAR ET AL 2,032,424

POTENTIAL CHANGER

Filed Sept. 27, 1932 4 Sheets-Sheet 2

Fig. 5

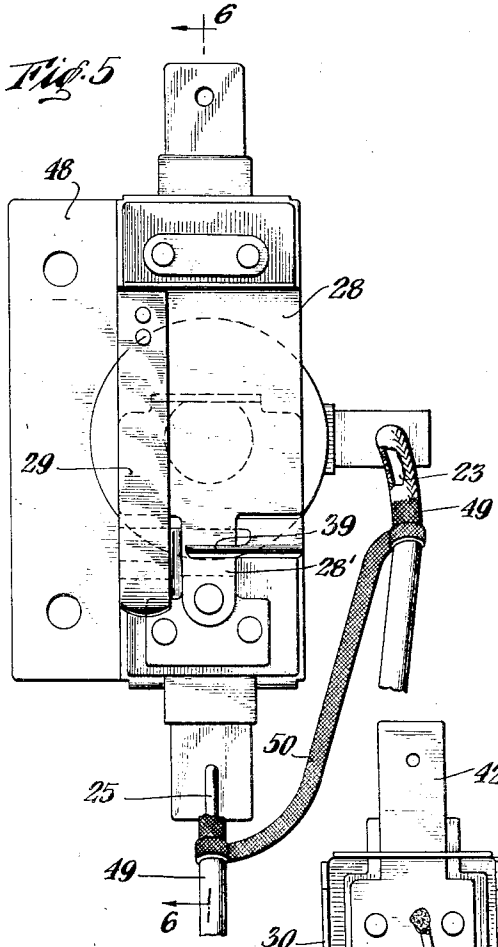


Fig. 6

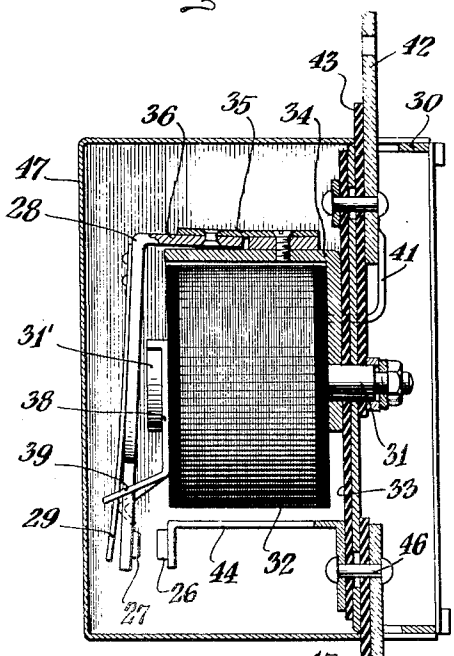


Fig. 8

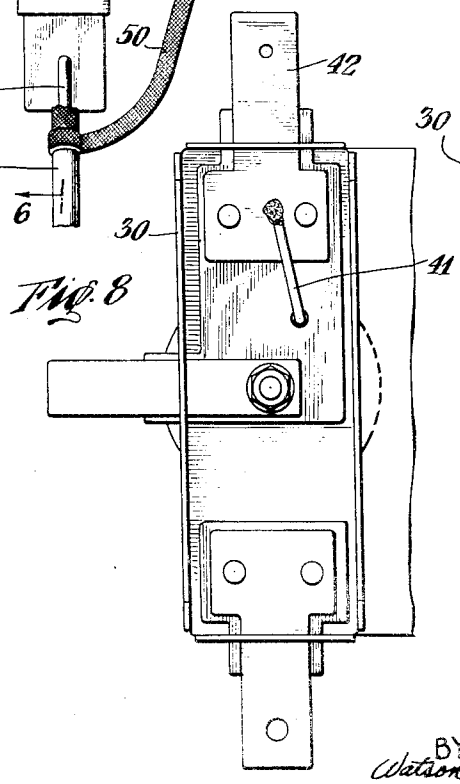
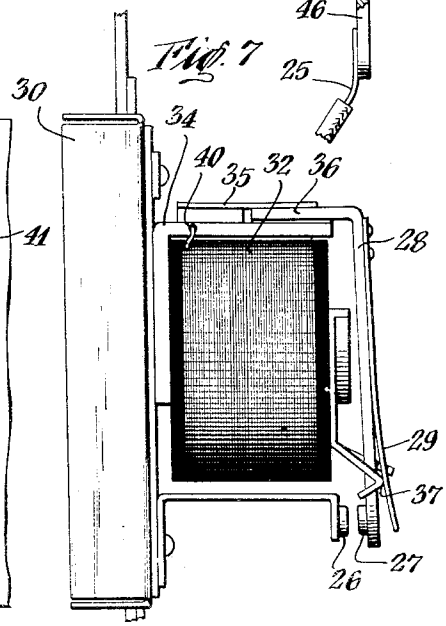


Fig. 7



INVENTORS
William P. Lear
Marvin E. Nulsen
Raymond S. Yoder
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

March 3, 1936. W. P. LEAR ET AL 2,032,424

POTENTIAL CHANGER

Filed Sept. 27, 1932 4 Sheets-Sheet 3

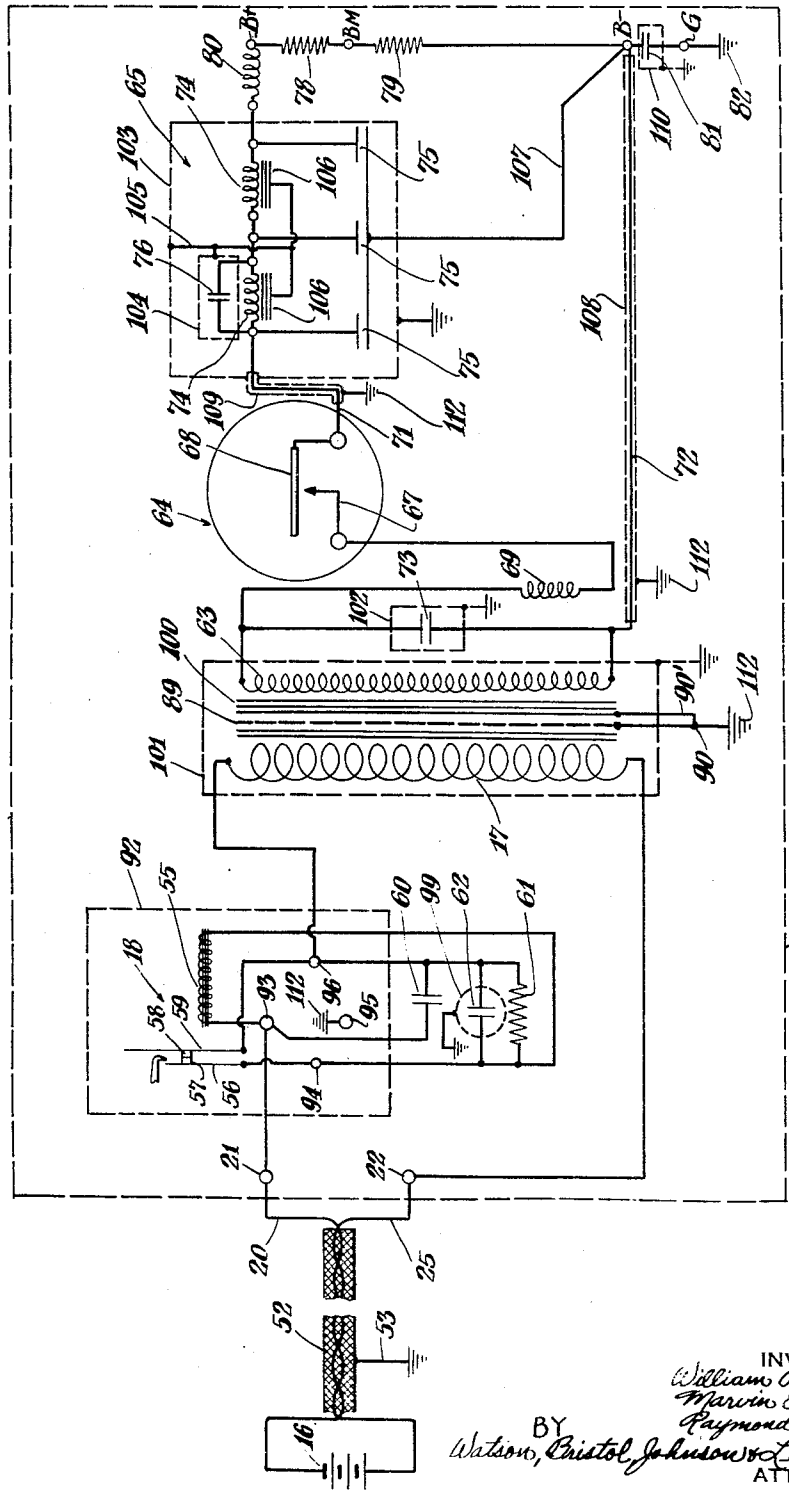


Fig. 9

INVENTORS
William P. Lear
Marvin E. Nelsen
Raymond S. Yoder

BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

March 3, 1936. W. P. LEAR ET AL 2,032,424

POTENTIAL CHANGER

Filed Sept. 27, 1932 4 Sheets-Sheet 4

Fig. 12

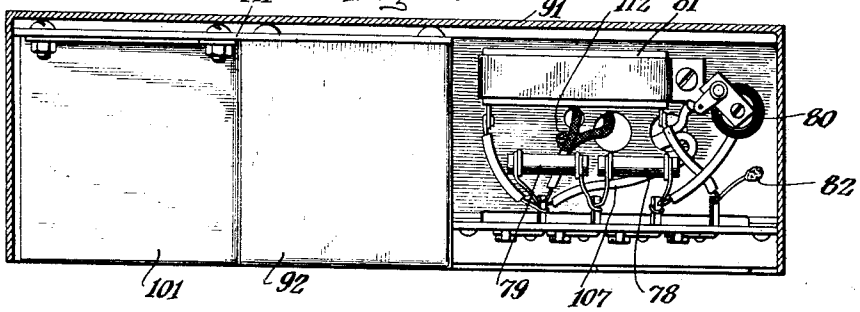


Fig. 11

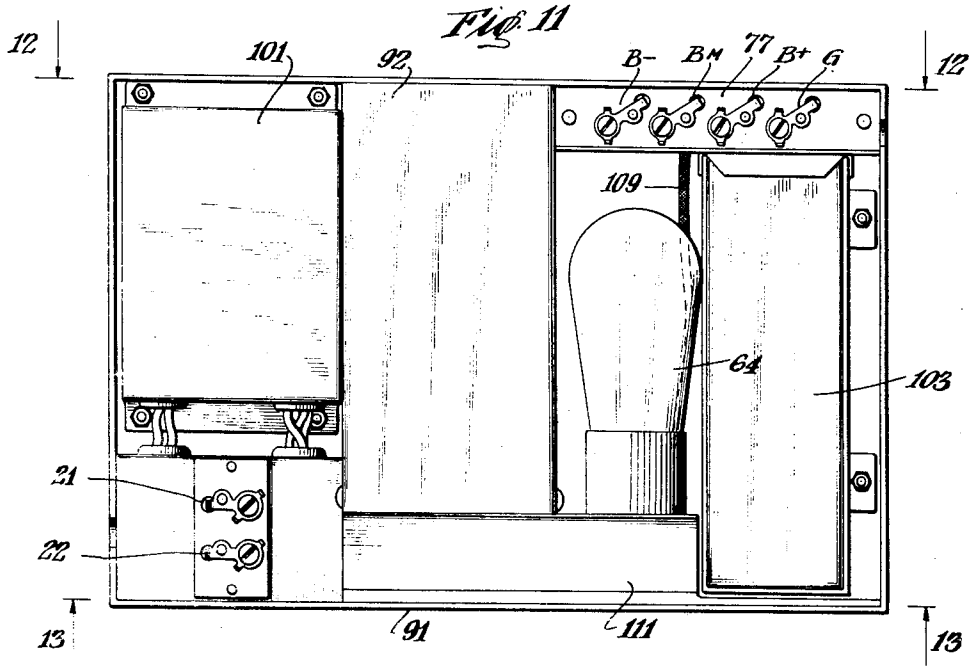
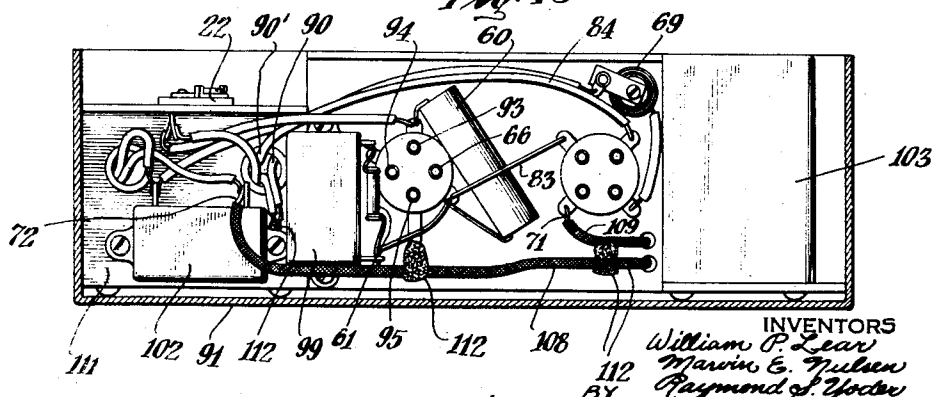


Fig. 13



INVENTORS
William P. Lear
Marvin E. Nulsen
Raymond S. Yoder
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

Patented Mar. 3, 1936

2,032,424

UNITED STATES PATENT OFFICE

2,032,424

POTENTIAL CHANGER

William P. Lear, Chicago, Ill., Marvin E. Nulsen, Indianapolis, Ind., and Raymond S. Yoder, Chicago, Ill., assignors to P. R. Mallory & Co., Incorporated, Indianapolis, Ind., a corporation of Indiana

Application September 27, 1932, Serial No. 635,056

3 Claims. (Cl. 171—97)

This invention relates to devices for changing potentials in both value and character and, more particularly, for changing low potential direct current to direct current of high potentials suitable for use as the "B" supply of radio receivers.

A general object of the invention is the provision of such a device which is efficient and quiet in operation, readily constructed, sturdy, has a long service life, requires minimum attention and when used as the "B" supply of a radio receiver, such as, for example, an automobile radio receiver, allows efficient operation thereof without the production in the receiver of troublesome interference effects even when supplied from the same source of direct current as is the filament circuit of the receiver and/or other electrical equipment, for example, the ignition system, of an automobile.

More specific objects of the invention are the provision of such a device provided with a primary circuit including in series a source of direct current, a transformer primary and a magnetic interrupter to make and break the primary circuit periodically, the series connection of the interrupter insuring continuous operation thereof and counteracting a tendency of the contacts to stick; and the provision of a relay in the primary circuit to allow remote control of the operation of the device which when used as the "B" supply for a radio receiver may be switched on and off with the similar operation of the radio receiver switch with the elimination of long supply wires in the primary circuit which have a tendency to introduce undesirable interference effects in the receiver.

Another object of the invention is the provision in such a device including a magnetic interrupter having in series a magnetic coil, a movable contact and a cooperating fixed contact, of a condenser shunted across the magnetic interrupter to reduce high frequency interference effects and a resistor of relatively high resistance, preferably of the non-inductive type, bridged across the interrupter contacts to reduce the transfer of contact metal under arcing conditions, together with a condenser bridged across the contacts to aid in the reduction of high frequency interference effects.

Additional objects of the invention are the provision in the secondary circuit including a transformer secondary, a rectifier unit and a filter circuit, of a pair of bridged contacts on the rectifier unit to cooperate with terminals of the primary circuit on the rectifier mount to prevent operation of the elements of the primary circuit and a flow of current therethrough when the rectifier unit is not in place; the provision of a condenser shunted across the transformer secondary which tends to reduce sparking at the interrupter contacts in the primary and a radio-frequency choke coil interposed between one side of the transformer secondary and the anode of the rectifier to reduce the transfer of radio-frequency interference effects which may be combined with a condenser shunted across the cathode and anode of the rectifier to cooperate with the choke coil in reducing the effects due to noisy tubes; and the provision of a radio-frequency choke coil between the positive side of the filter circuit and the apparatus to which the device delivers high potential direct current to prevent radio-frequency interference from being fed into the apparatus, and a condenser between the negative side of the filter circuit and a ground connection to by-pass the radio-frequency potentials choked out by the choke coil in the positive side.

Further objects of the invention are the provision of a complete and efficient system of shielding and arrangement of the various units and elements of such a device to reduce to a minimum the production of and/or transfer of high frequency disturbances due to the operations of units of the device and/or the ignition system and other electrical apparatus when used on an automobile, boat, etc., and in other situations where similar problems are involved, to supply the "B" potentials to a radio receiver, particularly where all of such devices, apparatus and systems are supplied from a common source of direct current, e. g., a storage battery, this system of shielding including a grounded static shield of electrically conductive metal between the transformer primary and the transformer secondary, a grounded metallic casing enclosing all of the units and elements of the device except the source of direct current and the cables between the device and this source of direct current, a grounded metallic shield enclosing the cables between the device and the source of direct current, a grounded metallic casing for the magnetic interrupter, a grounded metallic casing for the condenser bridged across the interrupter contacts, a grounded metallic casing for the transformer, a grounded metallic casing for the condenser bridged across the transformer secondary, a grounded metallic casing for the condenser shunted around a filter circuit inductance unit, a grounded metallic casing for the filter circuit, and grounded metallic shields for the cables between the filter circuit and the rectifier unit and

transformer unit, this system of shielding and grounding including ground connections for the transformer core and the core of any inductance unit; and the arrangement including the placement of the input or source terminals and output or "B" supply terminals as far apart as possible, preferably at diagonally opposite corners of the encased device to further reduce the possibility of transfer of interference effects.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the application which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a simplified diagrammatic view of the circuit of the device of the present invention;

Fig. 2 is an elevational view with parts broken away and parts in section of a rectifier unit used in the present device and provided with a bridging section for the primary circuit in accordance with the present invention;

Fig. 3 is a diagrammatic view of a modified form of a portion of the circuit shown in Fig. 1 to be used with a hot cathode type of rectifier;

Fig. 4 is a view of the relay device with connecting cables attached used in the primary circuit of the device of the present invention;

Fig. 5 is an enlarged top view of the relay device depicted in Fig. 4, with the cover removed;

Fig. 6 is a view taken on line 6—6 of Fig. 5 and with the cover in position;

Fig. 7 is an elevational view with parts broken away of the relay device depicted in Fig. 5;

Fig. 8 is a bottom view with parts broken away of the device depicted in Fig. 5;

Fig. 9 is a diagrammatic view of the circuit of the device of the present invention with various structural features and a system of shielding adapted to reduce and eliminate high frequency interference effects depicted thereon;

Fig. 10 is a diagrammatic view of a modified form of the magnetic interrupter, and associated resistor capacitors and encasing shield depicted in Fig. 9;

Fig. 11 is a top plan view of the encased device of the present invention with the cover removed;

Fig. 12 is a sectional view on line 12—12 of Fig. 11; and

Fig. 13 is a sectional view on line 13—13 of Fig. 11.

The device of the present invention is adapted to change potentials in both value and character, i. e., to change direct current potentials to alternating current of different potentials. It is additionally adapted to deliver the alternating current to any desired device, or to a rectifying and filtering system forming a part of the device to change the alternating current to direct current of high potentials which is suitable for use as the "B" supply of radio receivers. This device comprises a primary circuit and a secondary circuit, the primary circuit including a source of direct current, a transformer primary and a mechanical interrupter, such as a magnetic interrupter. The mechanical interrupter periodically makes and breaks the primary circuit causing a magnetic field to be built up periodically about the transformer primary and to allow such field to die down between the building up periods. The secondary circuit preferably comprises a transformer secondary, a rectifier and a filter circuit. The periodic building up and dying down of the magnetic field about the transformer primary causes an alternating current to be induced in the transformer secondary which is then preferably rectified and filtered by the other elements of the circuit to cause a direct current of relatively high potential to be delivered from the device which is suitable for use as the 'B" supply of a radio receiver.

Such a device is particularly adapted to use in an automobile wherein the radio receiver may be supplied with current from the same storage battery as is the ignition system and other electrical equipment of the automobile. To supply the device of the present invention with direct current from this common source of current presents problems of high frequency, such as radio-frequency, interference effects which distort and destroy the efficiency of the sound out-put of the radio receiver. Such effects may be due to a variety of causes including the association of this device with the source of current for the ignition system and the source of current for the filament circuit of the radio receiver. The physical proximity of elements of the circuit of this device to apparatus including periodically operated make-and-break contacts, the operation of which is attended by arcing and sparking, for example, the ignition system of the automobile and/or the magnetic interrupter of the device itself are likewise sources of such troubles. The present device is accordingly designed to reduce and substantially eliminate these interference effects and other difficulties encountered in such fields of use and to provide a device which will efficiently perform the functions for which it is intended.

Referring to the drawings and, more particularly, to the simplified diagrammatic view depicted in Fig. 1, the device generically comprises a primary circuit 14 and a secondary circuit 15, the primary circuit including a source 16 of low potential direct current, a transformer primary winding 17 and a mechanical interrupter 18, such as the magnetic interrupter shown. When the source 16 of low potential direct current consists of the usual 6 volt storage battery of an automobile it will be found that either the negative side or the positive side of this battery and the circuits of the electrical equipment of the automobile are grounded. In the drawings a system is depicted wherein the positive side is grounded at 19, this positive side then being connected by the cable 20 to an input terminal 21 of the device and the negative side being connected to an input terminal 22 through a cable 23, a relay 24 and a cable 25. Should the negative side of the battery 16 be grounded the connections of the cables 20 and 25 to the terminals 21 and 22 are reversed.

In a radio receiver mounted some distance from the source of current as in an automobile, a switch is desirable for closing the circuit of the device for supplying "B" potentials to the radio receiver which switch should be as accessible or closely associated with a switch for a filament circuit of the radio receiver. Long lead wires to such a switch are thus made necessary in the circuit of the "B" supply device which will be closely associated with portions of the circuit of the radio receiver giving rise to interference effects in the receiver due to the high frequency potentials set

up in the primary of the "B" supply device induced by the operation of the mechanical interrupter. The use of the relay 24 eliminates such undesirable features and the necessity of a separate switch for the "B" supply device.

This relay 24 includes a fixed contact 26 and a movable contact 27 associated therewith, both being connected in the primary circuit 14 of the "B" supply device. The movable contact 27 is mounted upon a movable arm 28 connected to cable 23 leading to one side of the current source 16. This arm 28 may be of resilient material so that there will be a tendency to separate the contacts 26 and 28, or may be provided with a spring 29 to perform this function.

Referring more particularly to Figs. 5, 6, 7 and 8, which depict various views of the relay 24, a base member 30 is provided with a centrally disposed aperture to receive a headed core 31 upon which a coil 32 is mounted. A sheet of insulating material 33 overlies the base and has a corresponding aperture to receive the core 31. An L-shaped integral member 34 is interposed between the sheet of insulating material 33 and the coil 32 to project up along one side of the coil 32 as depicted. A resilient strap 35 is secured to the member 34 and the movable arm 28 is provided with a right angle portion 36 which is secured to the resilient strap 35. The movable arm 28 is reduced near its free end to provide a narrow projecting portion 28' on which is mounted the contact 27. A spring leaf 29 is secured to the upper side of movable arm 28 so that it projects beyond the major portion of the arm 28 and parallel with the reduced portion 28'. The spring leaf 29 cooperates with a stop 37 made integral with a plate 38 secured under the head 31' of the core 31 and additionally provided with a guide 39 adapted to govern the space between the contacts 26 and 27. One terminal of the coil 32 is secured to the member 34 at 40 and the other terminal 41 is secured to a terminal piece 42 which is insulated from the base 30 by insulation 43. The contact 26 is mounted upon a support arm 44 insulated from the base 30 by sheets of insulating material 33 and 45, a rivet 46 serving to make electrical connection between the support arm 44 and the terminal member 46 to which the cable 25 is secured. A cover member 47 is fitted over the device and secured in position by frictional contact with the base 30. A mounting plate 48 is secured to the base 30 in any suitable manner.

The cables 23 and 25 are covered by suitable shielding 49, such as flexible woven copper, the shielding of these two cables being connected together by a flexible metallic member 50. Insulating sleeves 51 enclose portions of the shielding 49 as depicted in Fig. 4. The cable 20 is twisted up with the major portion of the cable 25 and this twisted portion is covered with shielding 49 and provided with a grounding tab 53 as depicted in Fig. 4.

In connecting this relay device into the circuit of the "B" supply, the cable 23, making electrical connection with the movable arm 28 through the member 34, is connected to the ungrounded side of the direct current source or battery 16 while cable 20 is connected to the other pole of the direct current source or battery 16 to which one side 54 of the filament circuit of the radio receiver is connected, the other side of this filament circuit being connected to the terminal 42 of the relay device.

The mechanical interrupter 18 is preferably of the magnetic type consisting of a coil 55 mounted in series with a contact arm 56 carrying a contact point 57 adapted to cooperate with the contact point 58 mounted on the vibratory reed 59 connected to one end of the transformer primary winding 17. Although series connection of this magnetic interrupter is preferred, shunt connection of this interrupter may be used wherein the major component of the current of the primary circuit which flows through the primary of the transformer and the contact points is independent of the magnetic circuit of the interrupter. Series connection, however, is greatly to be preferred since any tendency of the contacts to stick together and the resultant formation of high short circuit currents in the primary circuit is overcome by the high magnetic attraction on the interrupter vibratory reed or armature 59 by the magnetic field built up around the coil 55 by these high short circuit currents. Such connection of the interrupter thus provides a protective feature for the primary circuit, the magnetic interrupter automatically operating as a circuit breaker.

To reduce the transfer of high frequency potentials produced by the sparking and arcing of the contact points 57 and 58 a capacitor unit 60, preferably a non-inductively wound paper condenser of .05 mfd., is shunted across the magnetic interrupter 18. The rate of pitting and transfer of the material from one contact point to the other under conditions of arcing is decreased by the relatively high resistance unit 61 bridged across the contacts 57 and 58. A capacitor unit 62 is also preferably bridged across the contacts 57 and 58 to further reduce the transfer of the metal of the contact points and to effectively by-pass high frequency potentials produced by sparking and arcing at the contacts 57 and 58. The resistor 61 is preferably of about 400 ohms when the "B" supply device is used in an automobile with 6 volt direct current source, such as the usual storage battery, to prevent the continuous flow of any appreciable amount of current at the contacts 57 and 58.

The secondary circuit 15 of the "B" supply device generically comprises a transformer secondary 63, a rectifier unit 64 and a filter circuit 65. A half-wave rectifier unit 64 is shunt connected into the positive side of the secondary circuit. This rectifier, however, obviously may consist of a full-wave rectifier unit and/or of any suitable type, such as a cold cathode gaseous type, a hot cathode type in which the filament is energized by a third small winding on the transformer as depicted in Fig. 3 described below, an indirectly heated cathode type in which the filament is energized from the direct current source, a mercury vapor hot cathode type, a mercury vapor indirectly heated cathode type in which the filament is isolated from the tube atmosphere to preclude the flow of short circuit currents through the radio receiver, a cupric oxide or dry surface type, etc.

The cold cathode type rectifier depicted consists of an evacuated envelope 66 enclosing an anode 67 and a cathode 68, the anode 67 being connected to one side of the secondary 63 through a radio-frequency choke coil 69 to reduce the transfer of high frequency potentials to the rectifier unit 64. Intereference effects due to these high frequency potentials may, if desired, be further reduced by bridging a condenser 70 across the anode 67 and the cathode 68. The cathode 68 is connected to the positive side of the filter circuit 65 by a wire 71 and the other side of the

filter circuit is connected to the transformer secondary winding 63 by a wire 72.

Sparking and arcing of the interrupter contacts and the high-frequency interference effects due thereto may be further reduced by shunting a condenser 73 directly across the transformer secondary winding 63. As the capacitance of this condenser 73 is increased, the sparking at the contacts and its effects are reduced. However, as this capacitance increases, the over-all efficiency of the "B" supply device decreases, thus in a device having a 6 volt direct current source supplying approximately 30 milliamperes at 180 volts with an over-all system efficiency of approximately 45 per cent, a condenser having a capacity of .05 mfd. is selected. When, however, a hot cathode type rectifier is used, the filament being energized by a small third winding on the transformer, as depicted in Fig. 3, a condenser having a capacity of .025 mfd. is selected.

Any suitable type of filter circuit 65 may be used wherein one or more inductance units are connected in series in one side thereof and interposed condensers are bridged across between the negative and positive sides of the filter circuit. However, the filter circuit 65 shown is preferred. Two inductance units 74—74 are connected in series and three condensers 75—75—75 are bridged across the circuit, one being bridged across ahead of the inductance units 74—74, another being bridged across behind the inductance units 74—74, and the third being bridged across between the inductance units 74—74 as depicted in Fig. 1. An additional condenser 76 is preferably shunted around one of the inductance units 74.

The filter circuit 65 is preferably connected to a voltage divider 77 having a "B+" terminal, a "B_M" terminal and a "B—" terminal. A resistance unit 78 is connected between the "B+" and "B_M" terminals and a resistance unit 79 is connected between the "B_M" and the "B—" terminals. To substantially eliminate the transfer of any remaining high-frequency interference effects to the radio receiver, a radio-frequency choke coil 80 is interposed between the positive side of the filter circuit and the "B+" terminal. This radio-frequency choke coil, however, may, if desired, be connected between the "B+" terminal and the radio receiver. A by-pass condenser 81 is connected between the "B—" terminal and a ground connection 82 to by-pass the high frequency potentials choked out by the radio-frequency choke coil 80.

To prevent the flow of current through the primary circuit and the operation of any of the elements of devices connected therein when the rectifier unit is not mounted in the secondary circuit part of the primary circuit is mounted on the rectifier unit. A wire 83 leading from the mechanical interrupter 18 is connected to a contact or prong receptive jack on the rectifier unit receptive base and a wire 84 leading from one end of the transformer primary winding 17 is connected to a similar contact or prong receptive jack. The prongs 86 and 87 of the rectifier unit are bridged by a conductor 85 (see Fig. 2) and are adapted to make electrical connections with the above mentioned contacts or prong receptive jacks to complete the primary circuit.

In Fig. 3 is depicted a modified form of portions of the circuit of the "B" supply device made necessary by the use of a hot cathode type of rectifier unit. The hot filament cathode 68' is energized by a third winding 88 on the transformer and connected to one side of the filter circuit. One end of the transformer secondary winding 63' is connected to the anode 67' and the other end is connected to the other side of the filter circuit.

A complete and efficient system of shielding the various units of the device has been devised in accordance with the present invention to reduce the production and transfer of radio-frequency interference effects. The various features of this system of shielding have been perfected to obtain the greatest amount of efficiency for the system which includes the features listed below.

(1) A static shield 89 preferably of copper is interposed between the transformer primary and the secondary windings and grounded at 90. This static shield may consist of a sheet of copper wrapped around one of the windings, the edges of the sheet being spaced apart a short distance to prevent the formation of a closed circuit. The static shield may, if desired, be formed by the use of a layer of wire preferably having an insulating layer thereon, one end of this wire being grounded.

(2) A grounded metallic casing 91 is provided to enclose all of the elements of the "B" supply device except the source of direct current 16 and the in-put cables 20 and 25 together with the relay unit 24 when used, as depicted in Fig. 9.

(3) A metallic casing 92 encloses a magnetic interrupter 18. This casing 92 is formed from metal of good conductivity and high electro-magnetic permeability, such as pure iron, to prevent the transfer to other elements of the device of high-frequency disturbances produced by the opening and closing of the interrupter contacts and additionally to serve as a highly permeable path for the electro-magnetic and electro-static disturbances produced by the interrupter as a whole, including the electro-magnetic coil which is a potential radiator of such disturbances.

By using a prong base mount for the interrupter unit 18 this shielding feature is readily obtainable. The base of the casing, in accordance with one modification of the invention depicted in Fig. 9, is provided with four prongs 93, 94, 95 and 96 respectively, prong 93 being connected to one end of the magnetic coil 55, prong 94 being connected to the support 56 for contact 57 and the other end of the magnetic coil 55, prong 96 being connected to the vibratory reed 59 carrying the contact 58 and prong 95 being connected to a wire grounded to the base of the interrupter casing 92. Prong 93 makes contact outside the casing with a prong receptive jack connected to the in-put terminal 21 and one side of the condenser 60. The prong receptive jack for prong 94 is connected on the outside of the casing 92 to one end of the resistor 61 and one side of the bridging condenser 62. The prong receptive jack for prong 95 is grounded to casing 91 for the "B" supply device. The prong receptive jack for the prong 96 is connected outside the interrupter casing 92 to one end of the transformer primary winding 17, the remaining end of resistor 61, the other side of the bridging condenser 62 and the other side of the interrupter condenser 60.

In the modified form depicted in Fig. 10, the interrupter condenser 60, the bridging condenser 62 and the resistor 61 may be enclosed inside the interrupter casing 92. This avoids the necessity of four prongs for the encased interrupter unit, two prongs 97 and 98 being sufficient. It additionally allows the use of relatively short heavy leads to the condensers 60 and 62 which improves the efficiency of these elements in the elimination

of the high-frequency disturbances produced in this unit.

(4) When the capacitor units 60 and 62 are not included within the interrupter casing 92 as depicted in Fig. 9, these capacitor units are provided with separate grounded metallic casings. However, when the capacitor unit 60 comprises a non-inductively wound paper condenser as set forth above a grounded metallic casing is not necessary for this unit. The capacitor 62 bridging the contacts 57 and 58 is provided with a metallic shield or casing 99 grounded to casing 91 of the "B" supply device as depicted.

(5) The transformer primary winding 17, the transformer secondary winding 63, the interposed static shield 89 and the transformer core 100 are enclosed together in a metallic casing 101 suitably grounded to the casing 91 for the "B" supply device. The transformer core 100 is also preferably grounded to casing 91 of the "B" supply device by the wire 90'.

(6) The bridging condenser 73 for the transformer secondary 63 is provided with a metallic casing 102 grounded preferably to the casing 91 of the "B" supply device.

(7) The filter circuit 65 is enclosed in a separate metallic casing 103 grounded to the casing 91 of the "B" supply device, the shunt condenser 76 for the inductance unit 74 being separately enclosed within an additional metallic casing 104 disposed inside the filter circuit casing 103 and grounded thereto by wire 105 which may be utilized to ground the cores 106—106 of the inductance units 74—74.

(8) The cable 72 connecting one side of the transformer secondary 63 to the "B—" terminal of the "B" supply device, which is also connected to the negative side of the filter circuit by a short wire 107, is provided with a shield 108 preferably of flexible braided copper grounded to the casing 91 of the "B" supply device. The cable 71 connecting the cathode 68 of the rectifier unit 64 to the positive side of the filter circuit 65 is likewise provided with a shield 109 preferably of braided copper and grounded to the casing 91 of the "B" supply device.

(9) The by-pass condenser 81 connected to the "B—" terminal of the "B" supply device is provided with a metallic casing 110 grounded to the casing 91 of the "B" supply device.

As depicted in Figs. 11, 12 and 13, the casing 91 of the "B" supply device preferably consists of a relatively shallow metallic pan adapted to receive the "B" supply device as an assembled unit on the base member 111. The input terminals 21 and 22 and the out-put terminals "B—", "B_M" and "B+" are arranged at diagonally opposite corners so that they may be separated from each other as far as possible to prevent the transfer of interference effects to the circuit of the radio receiver, when it is connected to the same source of direct current. The casing 91 includes a removable cover (not shown) secured in place by screws, one of which may be utilized to secure to the casing 91 the grounding connection 53 of the cable shield 52, depicted in Fig. 4.

When the device of the present invention is used in an automobile as the "B" supply of a radio receiver with the use of the automobile 6 volt storage battery as the direct current source for both the receiver and the present "B" supply device various units thereof above described have been selected to give a maximum efficiency. The capacitor unit 60 is a non-inductively wound paper condenser of .05 mfd. The capacitor unit 62 and the condenser 73 are by-pass condensers of .05 mfd. The resistor unit 61 is a non-inductive resistor of 450 ohms. The by-pass condenser 81 is a 12 mfd. 30 volt unit. The resistance 78 in the voltage divider is a 20,000 ohm unit and the resistance 79 is a 75,000 ohm unit. All of the encasing containers are of iron and those within the case 91 for the complete unit are grounded thereto, the case 91 being grounded to the frame of the automobile. The cable sheathing 49, 52, 108 and 109 is of braided copper all grounded to the case 91. The transformer shield 89 is of copper and the rectifier 64 is a half-wave, cold cathode unit.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In an E. M. F. changer suitable for use as the biasing potential supply of the circuit of a radio receiver, the combination with a secondary circuit including a transformer secondary, a demountable rectifier and a filter circuit, of a primary circuit including a direct current source, a transformer primary and a magnetic interrupter including a magnetic coil and means for varying the flow of current through said transformer primary connected in series with said direct current source and said transformer primary with said primary circuit associated with said secondary circuit only through the transformer, whereby the potential of both sides of said secondary circuit is independent of the potential of either side of the primary circuit, and means associated with said demountable rectifier unit arranged so as to open said primary circuit when said rectifier unit is demounted to be removed from said circuit.

2. In an E. M. F. changer suitable for use as the biasing potential supply of the circuit of a radio receiver, the combination of a primary circuit including a potential source, a transformer primary in series therewith and a means for periodically interrupting the current from said source flowing in said winding, a secondary circuit including a transformer secondary winding inductively associated with said primary winding and a demountable rectifier unit in series with said secondary winding, and an electric metallically conductive circuit element mounted on said demountable unit and normally in series with said primary circuit, whereby removal of said demountable unit will open both said primary and said secondary circuits.

3. In an E. M. F. changer suitable for use as the biasing potential supply of the circuit of a radio receiver, the combination comprising a primary circuit including a direct current source, a transformer primary winding and means for periodically varying the current from said source flowing in said winding, a secondary circuit including a transformer secondary winding in inductive relation with said primary winding and

a demountable rectifying device in series therewith, said device comprising electric current rectifying means, a casing enclosing said means and a plug base on said casing, a first pair of contacts on said base, conductors within said casing connecting said contacts with said rectifying means, a second pair of contacts on said base, a metallic conductive circuit within said case connecting said contacts of said second pair, a receptive socket for said base having a first pair of contacts connected in series with said secondary circuit and arranged to co-operate with said first pair of plug contacts to connect said rectifying means in said secondary circuit, said socket having a second pair of contacts connected in series with said primary circuit and arranged to co-operate with said second pair of plug contacts, whereby removal of said demountable rectifying device from said socket will open said primary and secondary circuits.

WILLIAM P. LEAR.
MARVIN E. NULSEN.
RAYMOND S. YODER.