Feb. 28, 1939. J. D. REID 2,149,231

FREQUENCY CHANGER SYSTEM FOR MULTIPLE RANGE RECEIVERS

Filed Aug. 31, 1935 2 Sheets-Sheet 1

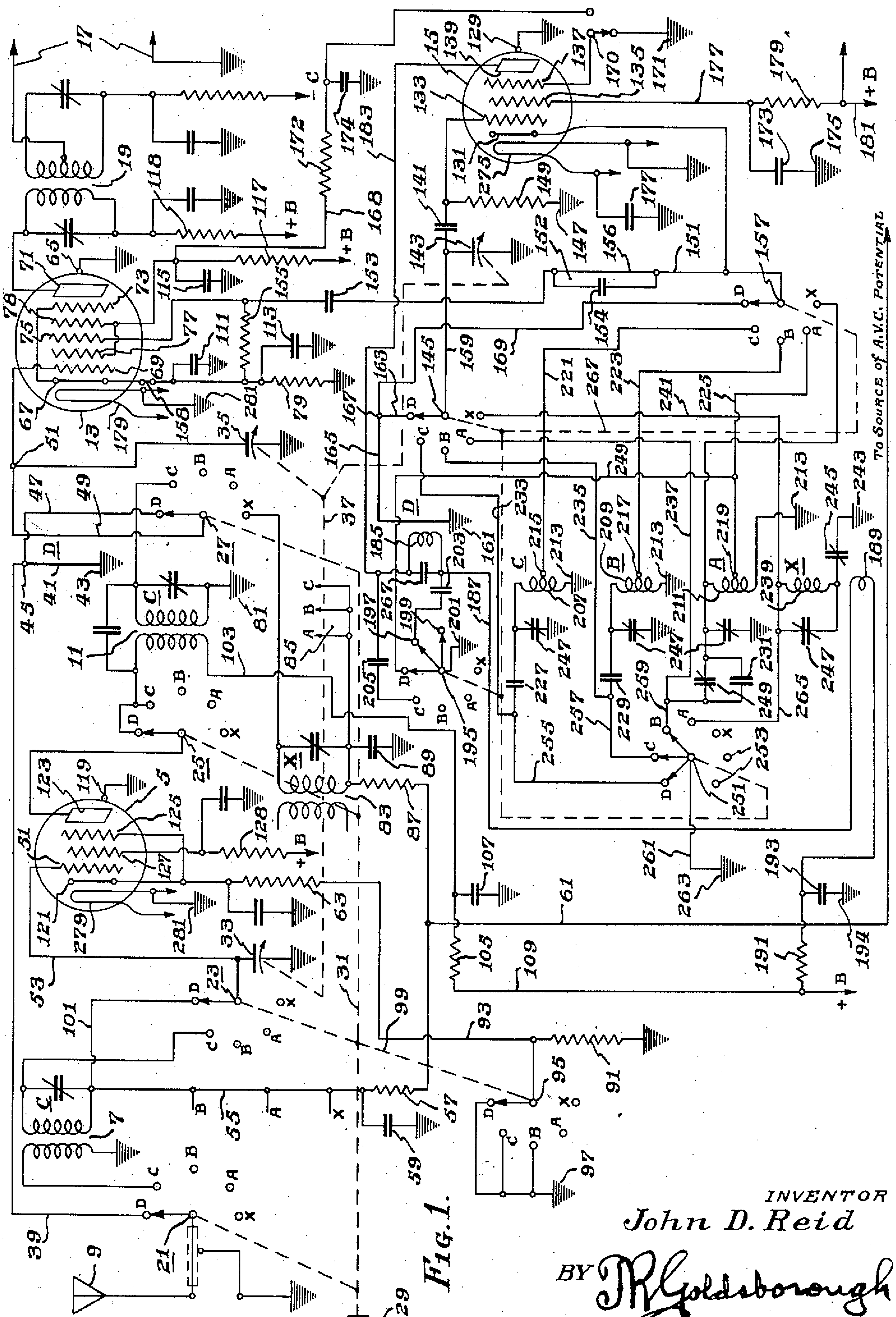

FIG. 1.

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FIG. 2.

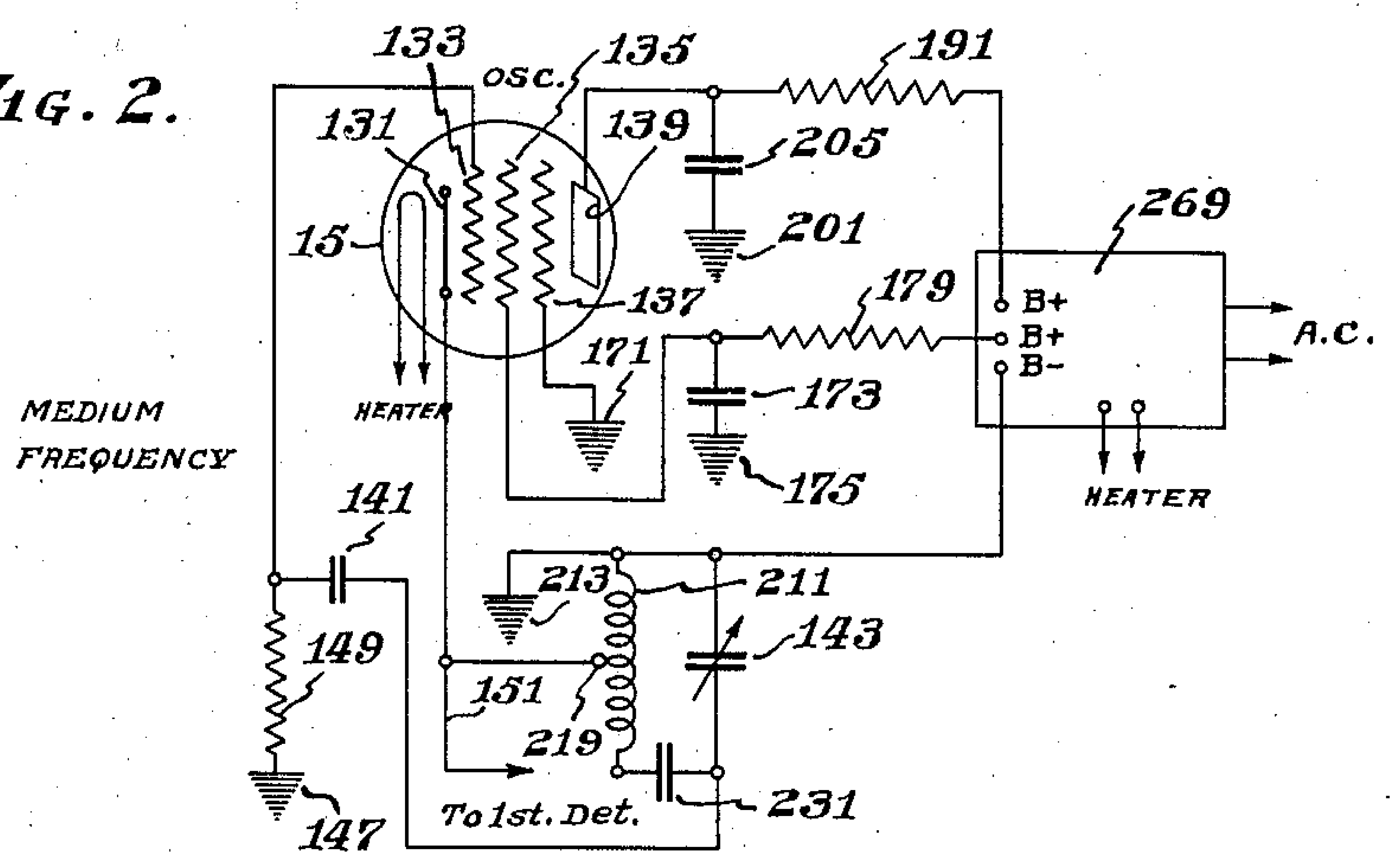


FIG. 3.

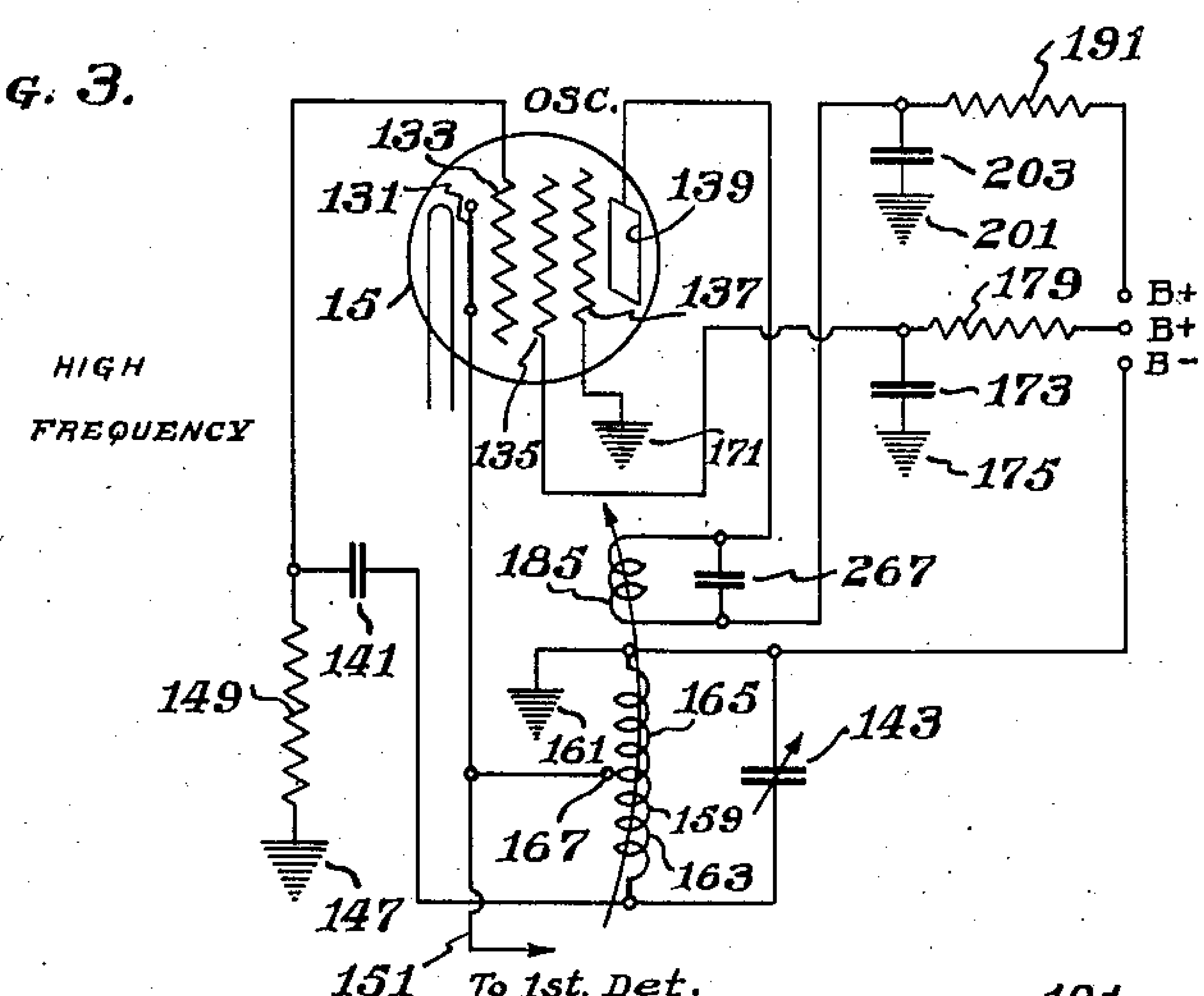
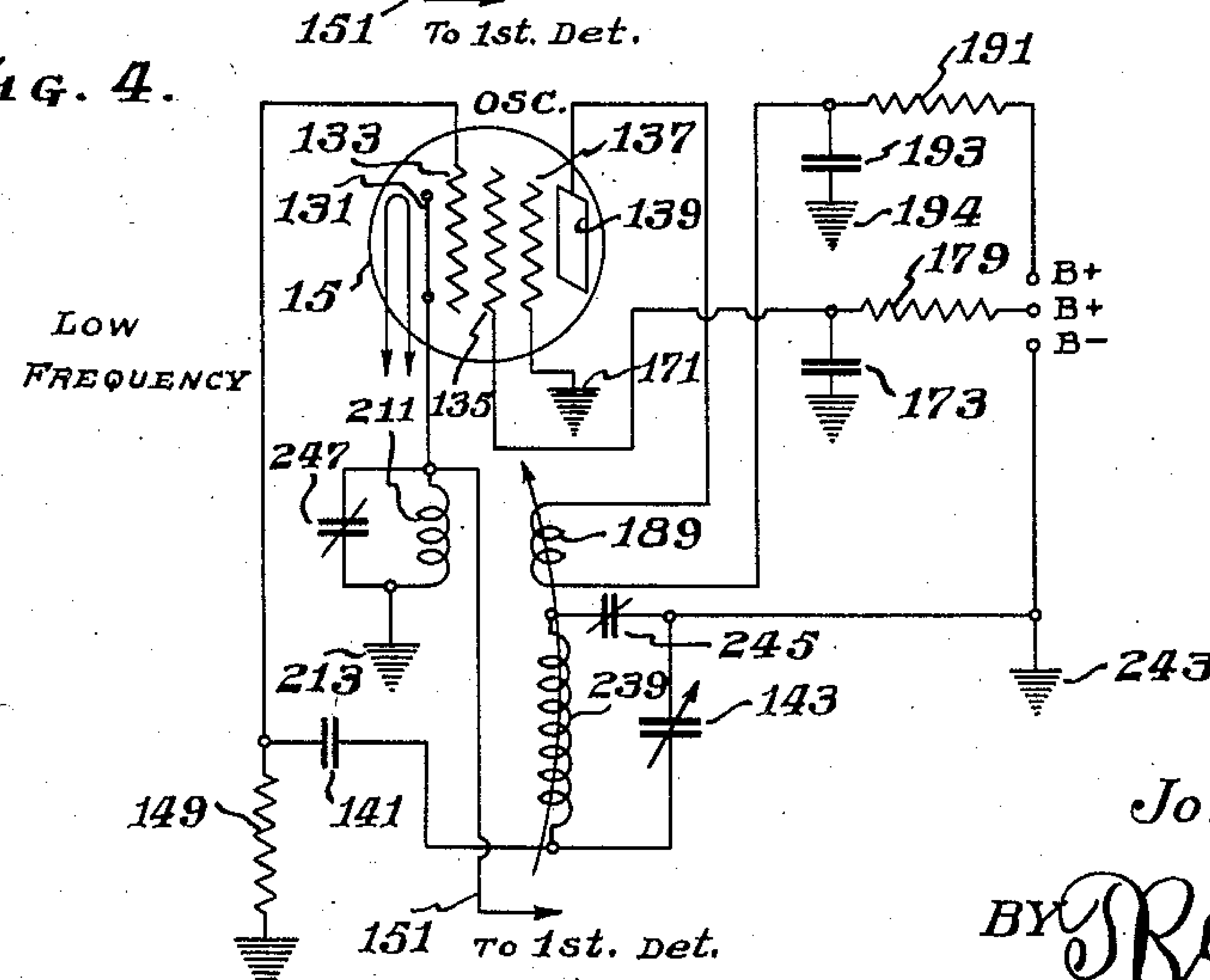


FIG. 4.



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FREQUENCY CHANGER SYSTEM FOR MULTIPLE RANGE RECEIVERS

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Application August 31, 1935, Serial No. 38,762

21 Claims. (Cl. 250—20)

The present invention relates to a frequency changer system for a multiple range radio receiver, of the type adapted to receive radio signals in a plurality of differing frequency bands or receiving ranges. Such receivers are in extensive commercial use at present. In order to provide relatively wide overall frequency coverage it is at present preferred to adjust the receiving circuits and oscillator by shifting coil connections with a common tuning capacitor and it is to this type of receiver that the invention more particularly relates.

The invention furthermore is concerned with the problem of providing effective coupling between an oscillator and a mixer or frequency changer tube, usually called the first detector, and the provision of an oscillator having improved stability in operation throughout the full range of adjustment of the receiver.

It is a primary object of the invention to provide an improved frequency changer system embodying a first detector and an oscillator whereby the frequency range of operation of the system may be adjusted through a plurality of individual, differing ranges providing relatively wide coverage and improved frequency stability in the oscillator.

It is also an object of the invention to provide an oscillator having uniform output over a given wide frequency range together with an improved coupling arrangement between the oscillator and the first detector which does not appreciably change the loading of the oscillator and the uniformity of signal output from the detector with change in frequency range of operation.

It is a further object of the present invention to provide an improved frequency band or tuning range changing system for an oscillator for a superheterodyne receiver and an improved coupling arrangement therefor whereby the frequency changer system in which it is included provides a signal output of substantially uniform amplitude.

Stated more fully, it is an object of the invention to provide an improved, multi-range, tunable, oscillator system embodying an electric discharge oscillator device and an improved frequency changer device in connection therewith so interconnected and jointly controlled in the various wave bands that uniform amplitude of oscillation, high stability and decreased reaction between the elements of the frequency changer device may be obtained together with a uniform detector signal output at all frequency bands.

In accordance with the invention, the oscillator, embodying an electric discharge oscillator device, is caused to be connected for differing modes of operation in a Hartley type of circuit generally and modifications thereof, depending upon the wave band or frequency range to be covered. Coupling with a mixer tube of improved electrode arrangement is provided between cathode and ground of the oscillator.

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

In the drawings,

Fig. 1 is a schematic circuit diagram of a portion of the signal input circuits of a superheterodyne receiver, including a frequency changer system embodying the invention, and

Figs. 2, 3 and 4 are simplified schematic circuit diagrams of the oscillator portion of the circuit of Fig. 1, showing connections for three differing modes of operation as provided by the circuit of Fig. 1.

Referring to Fig. 1, a radio frequency amplifier including an electric discharge device **5**, is coupled through an adjustable coil system, of which one coil or transformer **7** is shown, to a source of signal energy such as an antenna **9**. The amplifier **5** is in turn coupled through a coil system represented by a transformer **11**, with a first detector, frequency changer or mixer tube **13**, of the electric discharge type. An electric discharge oscillator device is indicated at **15** and forms part of an oscillator system, hereinafter described, for supplying oscillations to the mixer tube **13**. The latter is coupled to output leads **17** through a first intermediate frequency coupling transformer **19**.

The coil system for the high frequency amplifier **5** and first detector **11** may be of any suitable type, controllable by suitable tap switches **21**, **23**, **25** and **27**, connected for single control or gang operation by suitable means as indicated by the dotted connection **31** with a control knob **29**. The switches **23** and **27** represent means for shifting the grid connections of the tubes **5** and **13** while the switches **21** and **25** represent similar means for shifting the antenna and the plate connections for tube **5** simultaneously with the switches **23** and **27**, to the differing sets of coils in circuit with the tubes **5** and **13**, to provide a multirange tuning system for the radio frequency amplifier and first detector. The system is, however, adapted to provide a wide frequency range of operation. In the present example the switches are arranged to cover five differing wave bands which are arbitrarily designated as the X, A, B, C and D bands, the connections for the C and D bands only being shown to illustrate the particular connections provided in the present preferred system. In the circuit diagram, the coils are shifted in conjunction with suitable variable tuning capacitors 33 and 35 for the radio frequency or high frequency amplifier and the first detector or mixer tube respectively and these are in turn interconnected for gang operation by suitable means as indicated by the dotted connection 37.

For a further understanding of the wide frequency range covered by the system shown, the following frequency ranges may be assumed for the various bands.

X Band, 150–410 kilocycles	low frequency range
A Band, 540–1720 kilocycles B Band, 1720–6250 kilocycles C Band, 5600–18000 kilocycles	medium frequency range
D Band, 18000–65000 kilocycles	high frequency range

It will be noted that the tuning range may be divided into three main ranges, namely, low frequency, medium frequency and high frequency ranges.

In the present example, in the high frequency or D range, the first tube or radio frequency amplifier 5 is removed from the circuit, and signals from the antenna are directed from the contact B of the switch 21 through a lead 39 to the circuit wiring associated with the contact D of the grid switch 27 for the detector mixer tube 13. The wiring comprises a connection lead 41 beween the ground 43 and a tap 45, a second connection lead 47 between the tap 45 and the contact D of the switch 27 and a third circuit lead or wire 49 from the switch arm 27 through to a point of connection 51 with the tuning capacitor 35 for the grid or input circuit of the first detector 13.

In the D band or high frequency range, the inductance of the wiring alone is utilized in conjunction with the tuning capacitor to provide an auto transformer for coupling the antenna directly to the grid of the first detector 13, the primary of the auto transformer comprising the wire 41 and the secondary comprising the wire 41 and the wires 47 and 49 which, in the physical arrangement of a receiver, are connection leads of sufficient size to be rigid and cut to the proper length to provide the desired inductance to tune through the indicated range with the common tuning capacitor 35, in the high frequency band.

For the C band, which is within the medium frequency range, the coils or transformer 7 and 11 are utilized to couple the antenna with the radio frequency amplifier 5, and the latter with the detector 13 through the switching contacts C of the switches 21, 23, 25 and 27, the inductance of the transformers being such that the same tuning capacitors 33 and 35 may be utilized to tune through the C range as above indicated. The remaining bands B, A and X are similarly arranged and for the purpose of simplifying the drawings the inductances therefor have been eliminated since such switching connections are known and understood.

It should be pointed out, however, that for the remaining bands such as the X band, in connection with the first detector 13, the bias connections are changed by operation of the switch 27. The bias connections will further be understood from a consideration of the tube elements.

In the radio frequency amplifier 5, the control grid 51 is connected through an input lead 53 with the switch 23, then through the coil system to a common lead 55 in which is provided a filter comprising a series resistor 57 and bypass capacitor 59. Through the filter, the lead 55 is connected with a lead 61 providing a suitable source of automatic volume control potential as indicated. The connections for the various bands for the lead 55 are indicated in connection therewith.

The radio frequency amplifier 5 is provided with a self-bias resistor 63 to establish an initial bias in addition to the automatic volume control potentials received through the lead 61.

The first detector or mixer tube 13 is of the multiple grid type, termed a pentagrid-mixer-amplifier and may be of the type now to be known commercially as RCA-6L7. This is a new commercial type of tube having a grounded metal envelope 65. It is provided with an equipotential cathode 67, a control grid 69 and an output anode 71. In addition, it is provided with a suppressor grid 73 connected with the cathode, and three additional grids 75, 77 and 78, the latter two being screens on either side of the grid 75 and interconnected, whereby the latter grid is shielded from the control grid 69 and the output anode 71 by the grid 77—78 as well as by the suppressor grid 73.

The grids 77 and 78 provide a screen structure which may be termed a screen grid or screen for the second control grid 75. Radio frequency signals are applied to the first or inner control grid 69 and oscillations at a frequency to mix with the incoming signals are applied to the second control grid 75 as will hereinafter be described.

The grids 75 and 69 being in a common electronic stream between the cathode 67 and the anode 71, signals applied thereto are mixed to provide a desired intermediate frequency signal from the output anode 71 and thence through the intermediate frequency amplifier transformer 19.

The cathode 67 of the detector is provided with a self-bias resistor 79 and the inductances for the D and C bands are connected to ground, the ground for the C band being indicated at 81 and for the D band at 43, whereby the signal control grid 69 is self-biased for the said bands. For the remaining X, A and B bands, additional automatic volume control bias is obtained from the supply lead 61 through a filter comprising a series resistor 87 and bypass capacitor 89. The bias supply is taken through taps 85 as shown for the X band which is shown complete with the coil 83. With this arrangement, the first detector is provided with automatic volume control in certain of the lower medium frequency and low frequency ranges. It has been found that this arrangement tends to provide a more uniform output from the detector as is desirable, and prevents varying load conditions from affecting the oscillator on the higher frequency bands.

It will be noted that the radio frequency amplifier 5 is provided with an additional series resistor 91 in the cathode lead 93 and that this is controlled by a tap switch 95 having contacts corresponding to the contacts of the switches previously described. The contacts B, C and D are connected to ground as indicated at 97, while the contacts X and A are open circuited, thereby providing means for short-circuiting the additional resistor 91 in the B, C and D bands only. It will be seen that in the X and A bands the negative bias on the radio frequency amplifier is thereby increased by the amount of the potential drop in the resistor 91. The sensitivity of the receiver for the A and X bands is, therefore, simultaneously decreased with wave band change. The operating connection for the switch **95** is indicated by the dotted line connection **99**.

In connection with the radio frequency amplifier stage it should be noted that the contact D for the grid control switch **23** is connected through a lead **101** with the bias supply lead **55** whereby the tube is under control of the bias supply system although not in direct operation for the transmission of signals. Likewise, the D contact for the anode switch **25** is connected with the contact C whereby plate potential is maintained on the tube **5** for the D band. Anode supply for the tube **5** is provided through the supply lead **103** and in turn is connected, through a filter resistor **105** provided with a bypass capacitor **107**, to a potential supply lead **109**.

In connection with the detector tube **13**, the cathode is connected to ground for radio frequency potentials through suitable bypass capacitors **111** and **113** and the screen grid **77** is likewise grounded at radio frequencies through a bypass capacitor **115**. Both the screen grid and anode leads are provided with suitable series resistors **117** and **118** respectively.

It may be pointed out that the mixer or first detector tube **13** is provided with a relatively high plate impedance which is connected to the primary of the first intermediate frequency transformer **19** thus making it possible to obtain a greater selectivity in that transformer than has heretofore been possible. Furthermore, because of the location of the grids and relatively high degree of screening in the mixer tube **13**, the reaction between the signal and oscillator circuits has been reduced, that is, the reaction between circuits connected with the grids **69** and **75**. This is a material advantage in aligning the various circuits connected with the oscillator and detector.

Because of the electronic coupling of the second control grid **75** which is connected with the oscillator **15**, as hereinafter described, and because the grid **75** is well shielded, the direct coupling to the oscillator circuit and the capacity coupling therewith is relatively low. This results in less change of amplitude or frequency because of changes in load caused by tuning the circuit connected to the grid **69**.

The radio frequency amplifier **5** may be of any suitable type, but is preferably of a type comprising a metal grounded shield **119** containing an equipotential cathode **121**, an output anode **123** in association with the control grid, together with a suppressor grid **125**, and a screen grid **127**. It will be noted that like the screen grid and anode of the detector **13**, the screen grid **127** is provided with a series resistor **128** and the anode **123** is provided with the series resistor **105**.

In connection with the automatic volume control lead **61**, the same automatic volume control potential is applied to all tubes and the control of gain is regulated by the operation of the anode and screen grid series resistors, which, in operation, tend to raise the electrode potentials as the control grids are caused to become more negative in response to increased signal strength. By properly relating the resistance in the screen and anode circuits, the gain may be controlled without resorting to a voltage divider resistor for the automatic volume control circuit. This obviates the necessity for applying differing automatic volume control potentials to the various controlled tubes and simplifies the automatic volume control system.

The radio frequency amplifier tube may be of the type known commercially as the RCA 6K7, triple-grid control amplifier. The oscillator **15** is also preferably of the metal enclosed type comprising a grounded metal envelope **129**, an equipotential cathode **131**, a control grid **133**, a screen grid **135**, and suppressor grid **137**. The main anode is indicated at **139**. This may be of the type known commercially as RCA–6J7. The oscillator is of the grid leak and capacitor type, the control grid **133** being connected through a grid capacitor **141** to the variable tuning capacitor **143** to the contact arm of a grid switch **145** and is also connected to ground **147** through a grid leak **149** and thus through the coil to the cathode.

The cathode of the oscillator is directly coupled or connected to the second or outer control grid **75**, of the detector **13**, through a connection lead **151** and a grid or coupling capacitor **153**. A grid leak connection **155** is provided between the grid **75** and the cathode **67**. Both the oscillator grid **133** and the oscillation grid **75** are, therefore, grid leak and capacitor coupled to their respective sources of signal potential. The oscillation grid **75** receives oscillations from the cathode of the oscillator.

As a mixer tube or first detector, it has been found that the electrode arrangement best adapted for a high frequency range of operation in a broad frequency range, is with the inner grid **69** as the signal control grid while the second or outer control grid is utilized as the oscillation grid. As hereinbefore described, it is provided preferably with a grid leak and capacitor type of bias supply. The inner or control grid is provided with an automatic volume controlled or a fixed negative bias.

It has been found that this grid connection prevents degenerative action in the mixer tube as encountered heretofore in multigrid devices when the outer grid is utilized as the signal grid.

With the present arrangement, having the outer grid connected to the source of oscillations and to the cathode through a grid leak resistor, while the inner grid is utilized for the signal, the degenerative effect is not present and the device provides signal amplification instead. In this connection, therefore, the inner control grid will be referred to as the signal grid and the outer control grid as the oscillation or oscillator grid.

The control grid **133** of the oscillator is connected with the various wave band circuits controllable by the switch **145** and a second switch **157** is provided to change the cathode connections with said circuits. The latter switch may be termed the cathode coil-selector switch while the switch **145** is the grid coil-selector switch.

The grid coil-selector switch arm is connected with the tuning capacitor **143** through a rigid wire connection or lead indicated at **159**. The switch is provided with contacts corresponding in number to the number of wave bands to be covered, in this case five bands, and the switch contacts corresponding thereto are indicated at X, A, B, C and D for the wave or frequency bands hereinbefore indicated, and representing a plurality of bands covering a wide frequency range extending into a relatively high frequency range.

The contact D of the grid coil selector switch is connected to ground as indicated at **161** through a rigid wire connection or lead comprising two sections, **163** and **165**. An intermediate tap between the sections **163** and **165** as indicated at **167** is connected through a lead **169** with the contact D of the cathode selector switch 157 whereby, when the switch 157 is in the position shown, the cathode of the oscillator is connected to the tap 167.

The combined length of the lead wires 159 and 163 is such that, with the switch 145 in the position shown, sufficient inductance is included therein to form a grid inductance for the oscillator while the lead 165 to ground forms the anode inductance of a Hartley type oscillator, the total inductance being tuned by the capacitor 143.

The oscillator 15 utilizes both the main anode 139 and the screen grid 135 as anode electrodes, with the suppressor grid 137, between the two anode electrodes, connected to ground as indicated at 171.

The oscillator suppressor grid may be tied to the screen grid of the detector, bypassed to ground, and both grids may then be series fed from the positive +B supply source. This is of advantage when automatic volume control is applied to the detector as the screen voltage regulation is then such that the voltage change of oscillator suppressor grid counteracts changes in load on the oscillator caused by variations in the automatic volume control voltage on the detector.

In the present system, this connection may be provided by connecting the oscillator suppressor grid through a lead 168 with the detector screen grid or grid structure. A switch 170 is provided for breaking the suppressor grid connection with ground 171 and making the connection for the suppressor grid with the lead 168, whereby both the detector screen structure and the oscillator suppressor grid receive a positive potential through the common series resistor 117.

In order to decouple the two electrodes, a filter is provided in the lead 168, comprising a series resistor 172 and bypass capacitor 174.

It has been found that variations in screen grid current causing variation in the drop in the resistor 117, provide potential changes in the proper direction on the suppressor grid of the oscillator to maintain its plate or anode impedance at the proper values to counteract the load change of the detector tending to change the oscillator output amplitude and frequency.

The anode circuit for the screen grid 135 is completed to the ground 161 through a by-pass capacitor 173 and a ground connection 175 from the anode screen grid lead 177. A series resistor 179 is provided in the lead 177 between the screen grid and the source of anode or screen grid potential represented by the supply lead 181. This resistor has a desirable regulating function on the oscillator which will hereinafter be described.

The main anode 139 is connected through an output anode lead 183 to a feed back coil or winding 185, thence through a lead 187 to a second feed back coil 189 and is connected to a source of anode potential provided by the supply lead 109, through a series regulating and filter resistor 191 provided with a bypass capacitor 193. The function of the resistor 191 in regulating the oscillator and in conjunction with the resistor 179 will hereinafter be described.

With this arrangement, the screen grid 135 as an anode, is coupled in the oscillator circuit through the inductance of the lead 165, with the cathode connected to the tap 167, and grid connected to the end terminal of the inductance represented by the lead 159 and the lead 163 in series through the switch 145. Additional coupling is provided through the main anode 139 and the feed back winding 185 which comprises a few turns coiled adjacent to the grid switch 145 in inductive coupling relation to the wires 163 and 165.

An anode circuit switch having a three element movable contact arm 195 is provided with contacts corresponding to the selected wave bands X, A, B, C and D and, in addition, two spaced contacts 197 and 199, the latter contacts and the contact B being engaged by the three element contact and connected to ground 201, in the position shown. In this position, through the contact 197, the main anode circuit is shunted to ground through a bypass capacitor 203 on the low potential side of the feedback winding 185. The alternating current path from the main anode to cathode therefore, includes not only the feed back winding 185 but also the lead 165 or anode inductance, through the ground connections 201 and 161.

The contact C of the switch 195 is connected through a bypass capacitor 205 to the lead 183 and thereby to the anode 139 for connecting the anode directly to ground through the switch arm when the switch arm is moved to the left as viewed in the drawings to engage the contact C, and because of the triple arm, the contact C is connected to ground for the positions B and A of the switch 195. Since the contacts B, A and X are blank in the position X, the ground 201 is disconnected. Further use of the anode short-circuiting switch 195 will hereinafter appear.

The inductances for the frequency bands C, B and A are indicated at 207, 209 and 211 and are each connected through series capacitors 227, 229 and 231, respectively, to corresponding contacts C, B and A on the grid coil selector switch 145 through suitable grid leads 233, 235 and 237.

The inductance for the X band as indicated at 239 is an inductance without tap having the grid end connected to the contact X of the switch 145 to a lead 241 and having the opposite end connected to ground 243 through a series adjustable capacitor 245. Each of the inductances for the X, A, B and C bands is provided with shunt terminal capacitors indicated at 247 and the series capacitor 231 for the grid circuit of the A band is also provided with a shunt trimmer capacitor indicated at 249.

With this arrangement it will be seen that the cathode 131 of the oscillator and the oscillation grid 75 of the first detector or mixer tube may be connected to differing tap points on the various inductance elements for the various wave bands to be covered, while the control grid connection may be made to the grid ends of the inductances for the bands C, B and A through series capacitors 227, 229 and 231, respectively. The grid connection for the band X is made directly to the inductance 239. The inductance of the lead 159 between the switch 145 and the tuning capacitor 143 for the oscillator has a negligible effect in the lower frequency bands, such inductance having less than one percent of the inductance in the B band coils.

For the C, B and A bands, the oscillator anode connections for both the screen grid 135 and the main anode 139 are completed through the grounded ends of the inductances and the bypass capacitor 205, directly from the anode lead 183 and through the bypass capacitor 173 from the screen grid lead 177, both anode electrodes being thereby effectively coupled through the inductances of the C, B and A band.

In the X band, feed back for setting up oscillations, is derived from the feed back coil 189, which in the higher frequency bands is bypassed by the capacitors 205 and 203, but which for the X band is included in the alternating current path from the anode 139. In this case the screen grid 135 is ineffective to set up oscillations.

It will be noted that the lead 225 from the intermediate tap 219 of the inductance 211 for the band A is connected through a lead 249 with the contact D of the anode short-circuiting switch 195. This is for the purpose of short-circuiting to ground the anode portion of the inductance 211 for the bands C and D as well as the band B since this is the largest of the solenoid inductances and it has been found that the same tends to break up into portions which resonate at certain of the higher frequencies tuned through on the C and D bands unless the same is so short-circuited.

The grid ends of the inductances for the X, A, B, and C bands are also short-circuited to ground thereby to render the inductances ineffective to resonate at frequencies in the next adjacent lower bands, by a grid short-circuiting switch 251 having contacts D, C, B, A, X and two additional contacts 253 adjacent to the contact X in sequence of operation, which contacts with the contact X are blank. The main movable contact 251 comprises three fingers for engaging three adjacent contacts simultaneously in a similar manner to the switch 195. The contact D of the switch 251 is connected to the lead 233 through a lead 255 and similarly the contacts C and B are connected through leads 257 and 259 with the leads 235 and 237, respectively, the arrangement being such that in the position shown for the D band, the inductances for the bands C, B and A are short-circuited to ground through a lead 261 and a ground connection 263, whereby said inductances are ineffective to interfere with the operation of the D band inductance provided by the rigid wiring 159 and 163—165. As the switch 251 is moved in a clockwise direction as viewed in the drawings, the short-circuit is progressively removed from the C, B and A band inductances until the contact reaches the position X with the extreme left hand contact arm as viewed in the drawings, at the contact X, when all short-circuiting of the inductances is removed for the X band operation.

The grid and cathode coil selector switch 145 and 157 together with the anode and grid coil short-circuiting switches 195 and 251 are preferably interconnected for simultaneous operation in the relation shown and as indicated by the dotted connections 267.

It will be noted that for the X band operation the cathode switch 157 is connected through the contact X, thence through the entire coil of the band A to ground, whereby the inductance of the coil is included in the cathode circuit and across which coil a portion of the oscillator voltage will appear and will thus be transferred to the oscillation grid 75. In all of the other bands the oscillation grid 75 is connected across the anode portion of the oscillator coil or inductance and receives oscillator voltage therefrom directly.

Also, it will be seen that for the C, B and A bands the series capacitors 227, 229 and 231 are included in circuit with the tuning capacitor 143 and in the high potential side of the circuit. This arrangement for the A, B and C bands has the effect of changing the grid excitation over the tuning range in such a way as to maintain the voltage developed between cathode and ground substantially constant. The total oscillator voltage developed is least at the low frequency ends of the bands but the grid is effectively shifted toward the cathode at the low frequency end by virtue of the ratio between series and tuning capacitors so that a larger percentage of the oscillator voltage appears from cathode to ground.

On the highest frequency range D, a low frequency winding 185 is provided in the plate circuit of the pentode oscillator 15 to obtain oscillation over the low frequency end of the D band. It will be noted that this winding is provided with a shunt tuning capacitor 267. This is for the purpose of tuning the winding 185 below the tuning range of the B band, but adjacent thereto. The winding and shunt capacitor 267 constitute a tuned circuit in the main anode circuit which is resonant to a frequency preferably below the lowest frequency to which the oscillator is tunable in the D band. Therefore, at any frequency within the tuning range of the D band this circuit will act capacitively and the value of the capacitive reactance will increase with decrease in frequency. The arrangement is such that the circuit is, therefore, effective only in the lower frequency portion of the D band of the oscillator. This circuit is also used to regulate the rate of change of frequency as the oscillator is tuned over the D band, showing up this oscillator at the low frequency end, so that the oscillator will track with the antenna circuit without the necessity of including a series capacitor. In order that the oscillator circuits may more readily be understood the simplified circuits representative of the low frequency, medium frequency and high frequency connections have been redrawn without the switching, bypass and other elements, in Figs. 2, 3 and 4, Fig. 2 showing the general circuit arrangement for the medium frequency or A, B and C bands, Fig. 3 showing the circuit arrangement for the high frequency or D band, and Fig. 4 showing the circuit arrangement for the low frequency or X band. The same reference numerals have been used throughout in referring to the corresponding circuits and elements thereof as in Fig. 1.

Referring to Fig. 2, it will be seen that the screen grid 135 and the main anode 139 of the oscillator 15 are each bypassed to ground through bypass capacitors 205 and 173, respectively, thereby being connected through the ground 213, to the anode end of the inductance 211 across which is connected the tuning capacitor 143. The cathode 131 is connected to the intermediate tap 219 and to the lead 151 for the first detector oscillation grid. The control grid 133 is coupled through its grid leak and capacitor 149—141, to the grid end of the inductance 211, thereby providing a Hartley type oscillator. The suppressor grid 137 provides an effective screen between the two anode electrodes 135 and 139.

This use of a pentode device as an oscillator has been found to be effective in providing improved oscillator stability and uniform oscillator output. Additional means for stabilizing the output comprises the series resistors 179 and 191 between the supply means, indicated at 269, and the anode electrodes. The power supply means 269 represents any suitable power supply means for the receiving system, operated from a variable source of power such as alternating current and arranged to supply heating current to the apparatus.

The two series resistors in the anode circuits prevent the internal impedance of the oscillator tube and, therefore, the frequency of the oscillator system from varying appreciably from a predetermined adjustment. The voltage on the two electrodes is maintained substantially constant since the tendency to increase the B supply voltage tends to provide an increasing current and an increased drop in potential. This is further made more effective by the fact that the heater current is derived from the same source and simultaneously with an increase in B potential, the heater current is correspondingly increased, thereby causing an increased plate current and an increased drop in potential through the resistors 179 and 191.

By way of example, if the B voltage is 200 volts and assuming the resistors 191 and 179 to be so chosen as to provide a 40 volt drop, the anode potentials will thus be 160 volts. If the B voltage were to increase 10% to 220 volts, the plate and screen current would be increased approximately 10% causing a 10% rise in voltage across the resistors to a total of 44 volts and the new anode and screen potential would then be 176 volts.

However, because of the increased filament voltage of 10%, there will be an increase in plate and screen current of approximately 29%. This is caused by the fact that the filament temperature is proportional to the square of the voltage and the number of electrons emitted is approximately proportional to the square of the filament temperature which causes the number of electrons to increase at a very high rate with respect to the increased voltage.

The increased plate and screen current will cause the voltage drop across each of the resistors 179 and 191 to increase by approximately 29% or to a value of 53 volts. Subtracting 53 volts from the 220 volts B supply will provide a potential of 167 volts at the two anodes which is only slightly more than a 4% increase over that with normal B supply voltage although the supply voltage has increased 10%.

The effect of the combination of these features is to cause the plate resistance of the oscillator tube to remain substantially constant regardless of the voltage impressed thereon and, therefore, the oscillatory system tends to maintain the same frequency throughout very widely varying conditions of supply voltage.

It will be seen that both anodes, that is, the screen grid and the main anode are provided with a return circuit to cathode through the anode portion of the inductance 211 thereby providing an oscillator of the Hartley type having two anode electrodes separated by a grounded screen electrode and with the cathode and output connection floating above ground.

It will be noted that the A band inductance is selected for illustration in Fig. 2 as representing the other circuits of the medium frequency bands. In this connection the series capacitor 231 between the inductance and the tuning capacitor is shown. As has been pointed out hereinbefore, this is also a compensating capacitor for causing the output of the oscillator to be more uniform, thereby to apply to the first detector substantially the same output voltage for the high frequency and low frequency ends of the band. It will further be noted in Fig. 2 that the bypass capacitor for the anode 139 is the capacitor 205, this connection being provided by the switch 195 in the A, B and C bands as will be seen by referring to Fig. 1 thereby eliminating both feed back windings 185 and 189 from the alternating current circuit.

Referring now to Fig. 3, the connections for the high frequency or D band are shown in connection with the oscillator 15, the inductance of the rigid bus wiring being shown in conventional manner as inductances at 165 and at 159–163. It will be seen from an inspection of Fig. 3, that the change in connections effected therein includes removing the series compensating condenser 231 (Fig. 2) from the high side of the tuned circuit and adding the tuned feed back winding 185 which is tuned adjacent to and below the frequency band covered by the oscillator circuit in order to maintain the strength of the oscillations constant over the entire tuning range of the oscillator. This is done by boosting the low frequency end of the range by added feed back provided by the coil 185. It will also be noted that the bypass capacitor 203 is now effective in the main anode circuit caused by operation of the switch 195 thereby bypassing the feed back winding 189 shown in Fig. 1. The compensating resistors 191 and 179 are effective in the anode electrode circuits to maintain the plate impedance of the oscillator substantially constant as described in connection with Fig. 2.

Additional stability is obtained at the high frequency end of the D band by so proportioning the value of grid, anode and tuning capacitors and of the grid and anode inductances that the oscillator is effectively stabilized as to variations in voltages and load. The grid and anode capacitors may be made of equal value, and the grid and plate inductances 163 and 165 are of equal value without magnetic coupling between them. For low values of the tuning condenser this provides an additional stabilizing feature which is used to advantage over the higher frequency portions of the D range.

The first detector receives energy from the oscillator across the inductance 165 or the anode portion of the oscillator inductance as in the medium frequency range of the circuit shown in Fig. 2. This method of coupling the oscillator cathode with the second control grid of the mixer tube provides a relatively low load on the oscillator.

As in the preceding figure, and in the medium frequency ranges, both oscillator anode electrodes 135 and 139 include the anode inductance portion 165, the connections between the anode electrodes and the cathode comprising the capacitors 203 and 173 to ground, the ground 161 of the main tuning inductance, thence through the inductance element 165 to the cathode 131 from the tap 167 on the main tuning inductance. Both anode electrodes are thereby effective to maintain oscillations which are reinforced in the low frequency end of the tuning range of the oscillator by the feed back winding 185.

It will be noted that the anode electrodes 135 and 139 are shielded by the suppressor grid 137 which is connected to ground as in the medium frequency range.

Referring now to Fig. 4, the connections for the low frequency or X band range of operation are shown.

In this circuit the first detector is supplied with oscillations from the inductance 211 of the A band introduced into the cathode circuit between the cathode 131 and ground 213 and is shunted merely by the trimmer capacitor 247. Accordingly, it is tuned to a relatively high frequency above the tuning range of the oscillator for this band and operates as an inductance to provide coupling with the first detector through the lead 151.

The oscillations are set up wholly by feed back from the coil 189 and the main inductance 239 is not tapped but is utilized entirely in the grid circuit of the oscillator. Since the oscillator is required to cover a relatively narrow frequency range (1.42) the output may be maintained constant without special means other than provided by the coil introduced in the cathode circuit.

It will be noted that the inductance of the feed back winding 185 of Fig. 1 has been omitted since its inductance is negligible in this range and the bypass capacitor for the main anode 139 is indicated at 193.

The suppressor grid 137 is utilized as a screen between the anode electrodes 135 and 139 as in the other frequency bands and the compensating resistors 191 and 179 operate in the same manner to stabilize the oscillator frequency with variations in supply potential.

In the low frequency range it will be seen that the oscillator system is changed from the Hartley circuit to the feed back circuit with the screen grid 135 effective to control the internal impedance of the oscillator and the main anode 139 utilized for setting up oscillations by feed back.

The oscillator inductance is a single winding without taps. The feed back arrangement shown with its absence of taps is therefore decidedly advantageous in eliminating absorption circuits which would fall in a higher frequency band. Furthermore, the inductance in the cathode lead which is coupling means for the detector, provides an impedance from which to take the detector load without tapping into the tuned circuit. The inductor 211 being in the cathode lead is in a circuit common to the grid, screen, and plate. Therefore, while the screen grid is not provided with a return circuit through the main tuning inductance it is nevertheless coupled with the control grid and with the main anode through the inductor 211.

Referring again to Fig. 1 along with Figs. 2 to 4 inclusive, it has been pointed out that the oscillator circuit is arranged to cover a relatively wide frequency range of operation in a series of separate bands, while providing improved frequency stability and uniformity of ouput over the various tuning ranges. The oscillator operates on fundamental frequencies which are supplied to the first detector on an auxiliary mixing grid which in this case is the second control grid. The oscillator generates signals which, in all bands, are above the frequency of the incoming signal by the amount of intermediate frequency which, in this case, is chosen at 460 kilocycles.

As shown in the drawings, the cathode of the oscillator is above ground potential for high frequency oscillations while the anode or plate is effectively at ground potential. This arrangement together with the plate and screen series resistors causes the circuit to be substantially independent of power supply variations in regard to stability and uniformity of output.

Separate coils or transformers are used for each of the tuning ranges. The switching of the different bands is such as to short-circuit certain unused coils which would absorb energy from the circuit in use.

The overall oscillator circuit comprises five separate transformers or coils, the D band transformer or coil being provided by the circuit wiring. Four selector switches are provided, the switch 195 being the anode coil short-circuiting switch, the switch 251 being the coil short-circuiting switch and the switches 145 and 157 being the grid coil and cathode coil selector switches respectively. The switch 145 serves to connect the grid of the oscillator and the main tuning capacitor 143 to the proper coil for the range to which the switch is adjusted. The switch 157 serves to connect the cathode and the first detector to the appropriate part of the circuit being the plate or anode portion of the inductance for all bands except the X band when it introduces an inductance in the cathode circuit for coupling with the detector.

The switch 195 serves to bypass the inductance 185 which is the D band feed back coil when the A, B or C ranges are used. However, as this coil has such low inductance it is not necessary to bypass it when the long wave length band X is in use. The switch 195 also serves to ground the plate portion of the A band coil when the bands B, C or D are being used. The switch 251 serves to detune the coils of the three bands immediately below the one being used. This detuning is accomplished by connecting the series condensers for the A, B and C bands across the coil, thus tuning it to a low frequency and avoiding any possibility of interference with the higher frequency bands in use by the absorption of energy.

In the case of the A band coil, since it is divided into a large and small section by the tap there is a tendency for the lower or plate section of the coil to resonate in band C and D although the whole coil is detuned. Therefore, the plate portion is short-circuited also in addition as above described, through the switch 195.

The coil for the D band comprises merely a piece of rigid wire extending from the ground to the switch 145 and thence, when the switch is thrown to the position D, through to the tuning capacitor 143. The capacitor tunes the piece of rigid wiring to the proper frequencies. It is, therefore, necessary that the length of the wire and the location of the same be maintained in position after adjustment.

Because of the extremely high frequency to which the oscillator responds it is necessary that exceedingly short ground connections be used at certain points. For example, as shown in Fig. 1, the heaters and the cathodes are preferably bypassed directly to ground at the tube terminals except at the oscillator, the cathode of which is used for coupling purposes. In this connection it will be noted that the heater of the oscillator indicated at 275 is grounded for high frequency currents, one leg directly and the other through the bypass capacitor 177. Likewise, the radio frequency amplifier 5 and the detector 13 are provided with heaters 279 each provided with a direct ground connection as indicated at 281 adjacent to the tube terminals.

Likewise the shield or metal envelope of the oscillator is directly connected to ground, a minimum length of lead being used. These direct connections are of importance in order to prevent spurious oscillations or responses at the high frequency end of D band, as the circuits within the detector tube, i. e. the elements thereof have natural periods corresponding to frequencies of 180–220 megacycles. The harmonics of the oscillator that fall in the range of 180–220 megacycles so excite the detector tube that responses denoted by hiss output at intermediate frequency are obtained. In order to prevent these spurious responses, it is necessary to have the filaments.

shields and cathodes of the first detector and oscillator tubes grounded by paths which have a minimum of impedance at 200 megacycles. In some cases it may be desirable to include a trap in the oscillator coupling lead tuned in the neighborhood of 200 megacycles to prevent the oscillator harmonics from reaching the detector. Such a circuit is shown at 152 and may consist of a 9 micro-microfarad capacitor 154 connected across several inches of the lead 151 providing an inductor 156 between the oscillator cathode and the detector coupling condenser 153.

This trap may also be inserted at 158 in the detector cathode lead to provide degeneration at 200 megacycles.

From the foregoing description it will be seen that an oscillator, first detector or frequency changer system is provided wherein

(*a*) Minimum reaction is obtained between the oscillator and the radio frequency or signal input circuits and minimum loading of the oscillator.

(*b*) A relatively high signal output is obtained from the first detector thereby avoiding an excessively high noise ratio with respect to signal.

(*c*) A high degree of oscillator stability is obtained, thereby preventing variation in the signal output of the receiver when it has once become tuned to a required signal.

(*d*) The oscillator is arranged to oscillate uniformly throughout all of the wave bands in a wide range coverage. In the present example, this includes a range of 17.8 to 73 megacycles for the D band alone.

(*e*) The oscillator output voltage delivered to the first detector or mixer tube is uniform throughout the various wave bands covered thereby improving the efficiency of conversion in the first detector or mixer tube. The automatic volume control is simplified, since the screen grid and anode circuits are controlled by suitable series compensating resistors regulating the gain of the system in response to strong signals of high amplitude.

While the combination has been shown and described in connection with a 5 band superheterodyne receiving system, it should be understood that it may be applied to similar systems having fewer or a greater number of wave bands for wide frequency range coverage.

I claim as my invention:

1. In a superheterodyne receiver, the combination of an electric discharge device having a cathode, an anode, an inner control grid and an outer control grid between said cathode and anode, means for applying signals to the inner control grid, an electric discharge oscillator device having a cathode and an anode, means providing a tuning inductor having a terminal connected to said last named cathode and being connected at another terminal with the anode of the oscillator, and means providing a coupling connection only between the cathode terminal of said inductor and the outer control grid for applying oscillations thereto.

2. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid, an outer control grid, a plurality of tunable signal circuits, means for selectively connecting each of said tunable signal circuits to said first named control grid, a pentode electric discharge oscillator device, a plurality of tunable oscillator circuits, means conjointly operable with said first named connecting means for selectively connecting each of said tunable oscillator circuits with said oscillator device, inductance means in at least one of said last named tunable oscillator circuits having a cathode connection for the oscillator intermediate its ends, and means providing a connection between the oscillator cathode and the outer control grid of the mixer device.

3. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid, an outer control grid, means for selectively connecting a plurality of tunable signal circuits to said first named control grid, a pentode electric discharge oscillator device, having a cathode, an outer anode, a screen grid, a suppressor grid and a control grid adjacent to the cathode, means simultaneously operable with said first named selectively connecting means for connecting a plurality of tunable oscillator circuits with said oscillator device, means in at least one of said last named tunable circuits providing an inductance between the cathode and both the anode and the screen grid in common, means providing a grid leak and capacitor coupling between the cathode of the oscillator and the second named control grid of the mixer device, and means for simultaneously tuning said signal and oscillator circuits.

4. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid and an outer control grid, means for connecting each of a plurality of tunable signal circuits selectively to said first named control grid, an electric discharge oscillator device having a cathode, an anode, a screen grid, a suppressor grid, and a control grid adjacent to the cathode, means simultaneously operable with said first named connecting means for connecting a plurality of tunable circuits with the oscillator control grid, means in at least one of said last named tunable circuits providing an inductive winding in circuit with the oscillator between the cathode and both the anode and the screen grid in common, said winding being grounded at one end, means providing a coupling connection between the cathode of the oscillator and the outer control grid of the mixer device, means for simultaneously tuning said signal and oscillator circuits, a regulating resistor in series each with the screen and anode of the oscillator, means providing a high frequency bypass connection to ground for said screen grid and outer anode, and means for supplying operating current to the cathode and to the anode and screen grid of the oscillator from a common source.

5. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid and an outer control grid, a screen structure for said second control grid, a suppressor grid adjacent to the anode and connected with the cathode, said device having a relatively high output impedance, means for selectively connecting a plurality of tunable signal circuits to said first named control grid, an electric discharge oscillator device having a cathode, an anode, a screen grid, a suppressor grid, and a control grid adjacent to the cathode, means simultaneously operable with said first named connecting means for selectively connecting a plurality of tunable circuits with the oscillator control grid, means in at least one of said last named tunable circuits providing an in-

ductive winding between the cathode and both the anode and the screen grid in common, said winding being grounded at one end, means providing a grid leak and condenser coupling between the cathode of the oscillator and the outer control grid of the mixer device, means for simultaneously tuning said signal and oscillator circuits, a regulating resistor in series each with the screen and anode of the oscillator, means providing a high frequency bypass connection to ground for said screen grid and outer anode, means for supplying operating current to the cathode and to the anode and screen grid of the oscillator from a common source, a series resistor in circuit with the screen of the mixer device, and means providing a connection between the suppressor grid of the oscillator and said mixer screen, whereby a common operating potential is applied to said electrodes through said last named series resistor.

6. In a superheterodyne receiver, means including a plurality of tapped inductance elements for tuning the oscillator through a relatively wide frequency range in a plurality of successive frequency bands, a feed back winding inductively coupled with one of said inductance elements, said winding being tuned below and adjacent to the band of frequencies in which said inductor is tunable, an oscillator device having a cathode, an anode, and a screen grid, circuit means connecting said anode and screen grid jointly to one end of each of a plurality of said inductance elements, means providing a tap connection for the cathode selectively with each of said plurality of inductor elements, an electric discharge detector device having an inner negative signal grid and an outer oscillation grid, the last named grid being coupled with the oscillator cathode to receive oscillations therefrom successively across said inductor elements.

7. In a superheterodyne receiver, means including a plurality of tapped inductor elements for tuning the oscillator through a relatively wide frequency range in a plurality of successive frequency bands, the oscillator tuning means in a predetermined high frequency tuning range including linear circuit leads forming the sole inductor element, a feed back winding for the oscillator inductively coupled with one of said leads, said winding being tuned below and adjacent to the band of frequencies covered by said high frequency tuning range, an oscillator device having a cathode, an anode, and a screen grid, circuit means connecting said anode and screen grid jointly to one end of each of a plurality of said inductor elements, means providing a tap connection for the cathode selectively with each of said plurality of inductor elements, an electric discharge detector device having an inner negative signal grid and an outer oscillation grid, the last named grid being coupled with the oscillator cathode to receive oscillations therefrom successively across said inductor elements, means for regulating the anode impedance of the oscillator, and tuning means in circuit with the oscillator effective to provide a uniform output potential from said cathode connection to the oscillation grid of the detector device.

8. In a superheterodyne receiver, means including a plurality of tapped inductor elements for tuning the oscillator through a relatively wide frequency range in a plurality of successive frequency bands, a feed back winding inductively coupled with one of said inductor elements, said winding being tuned below and adjacent to the band of frequencies in which said inductor is tunable, an oscillator device having a cathode, an anode, and a screen grid, circuit means including a ground connection for connecting said anode and screen grid jointly to one end of each of a plurality of said inductor elements, means providing a tap connection for the cathode selectively with each of said plurality of inductor elements, an electric discharge detector device having an inner negative signal grid and an outer oscillation grid, the last named grid being coupled with the oscillator cathode to receive oscillations therefrom successively across said inductor elements, a second feed back winding for a predetermined low frequency tuning band inductively coupled to the oscillator inductor element for said band, said feed back winding being connected in circuit with the oscillator anode, and a suppressor grid in the oscillator device connected to ground.

9. In a superheterodyne radio receiving system, tunable over a plurality of differing frequency ranges, the combination of a detector having a signal grid and a second grid, an electric discharge oscillator device of the pentode type, means including differing individual inductor elements and a common tuning capacitor for tuning said oscillator over a plurality of differing frequency ranges, a plurality of said inductor elements comprising grid and anode portions and having an intermediate cathode tap, selective switching means providing cathode and grid connections for the oscillator selectively with said taps and grid portions, and providing connections for the second grid of the detector selectively with said taps, and means providing feed back connections selectively through the anode portions of said inductors to the cathode from at least two positive electrodes in said oscillator.

10. In a superheterodyne radio receiving system, tunable over a plurality of differing frequency ranges, the combination of a detector, an electric discharge oscillator device of the pentode type coupled thereto, means including differing individual inductor elements and a common tuning capacitor for tuning said oscillator over a plurality of differing frequency ranges, a plurality of said inductors comprising grid and plate portions and having an intermediate cathode tap, and the grid and anode portions of the inductor for the highest frequency range comprising substantially linear circuit leads, said oscillator comprising a cathode, an anode, a control grid, a screen grid and a suppressor grid, the suppressor grid, screen grid and anode being provided with high frequency paths of low impedance to ground, and said inductor elements being connected at the anode end to ground whereby said electrodes are connected to cathode through the anode portions of said inductor elements, and means providing additional feed back coupling for the anode with said inductors in certain of the frequency ranges, said feed back coupling means in the highest frequency band including a feed back winding tuned to a frequency below the lowest frequency in said band.

11. A superheterodyne radio receiving system as defined in claim 10 including a detector device having an inner signal grid and an outer oscillator grid, and means for coupling said oscillation grid to the cathode of the oscillator, said means including an inductor for a differing frequency band in circuit with the cathode.

12. An oscillator for a superheterodyne re-

ceiver tunable through a plurality of differing frequency ranges, comprising an electric discharge device of the pentode type having a cathode, a control grid, a screen grid, a suppressor grid, and a main anode, means providing a plurality of selectable tuning inductors and a common tuning capacitor therefor, means providing a low impedance path to ground for high frequency currents between the anode and the screen grid, and one end of each of the tuning inductors, means for selectively connecting the oscillator cathode with an intermediate tap and the control grid with the ungrounded end of each of said inductors, the cathode and control grid connections being shiftable simultaneously in connection with the same inductor, said oscillator being thereby operative throughout a plurality of said frequency ranges, means providing a feed back winding with the anode in coupling relation to certain of the inductors for the lower and higher frequency bands, said feed back winding for a predetermined higher frequency band being tuned below and adjacent to said band, and a signal detector and mixer device of the electric discharge type having an inner signal grid, and an outer oscillation grid coupled to the cathode of the oscillator by a direct connection including a grid leak and condenser for the oscillation grid.

13. In a superheterodyne receiver, a detector, means including a plurality of individual tapped inductor elements for tuning the oscillator and signal circuits thereof through a relatively wide frequency range in a plurality of successive frequency bands, the oscillator tuning means including linear circuit leads forming the sole inductor element in a higher frequency band, a feed back winding in the oscillator anode circuit inductively coupled with one of said leads, said winding being tuned below and adjacent to the band of frequencies covered by said higher frequency band, a second feed back winding in the oscillator anode circuit for a low frequency band inductively coupled to the inductor element for said band, a suppressor grid in the oscillator device connected to ground, and means for coupling the cathode of the oscillator with said detector.

14. In a superheterodyne receiver, a frequency changer system comprising an electric discharge tube detector having a cathode, an output anode, a control grid more adjacent to the the cathode, a second control grid more adjacent to the anode, means providing a plurality of tunable signal input circuits, means for selectively connecting said circuits with the first named control grid, an intermediate frequency output circuit connected with said anode, an electric discharge oscillator having a cathode and an anode, means providing a tuning inductor having a terminal connected to said last named cathode and being connected at another terminal with the anode of the oscillator, and means providing a coupling connection between the cathode terminal of said inductor and the outer control grid for applying oscillations thereto.

15. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid and an outer control grid, means for connecting each of a plurality of tunable signal circuits selectively to said first named control grid, an electric discharge oscillator device having a cathode, an anode, a screen grid, a suppressor grid, and a control grid adjacent to the cathode, an inductive winding in circuit with the oscillator between the cathode and both the anode and the screen grid in common, said winding being grounded at one end, and means providing a coupling connection between the cathode of the oscillator and the outer control grid of the mixer device.

16. In a frequency changer system for high frequency signal and locally generated oscillations, the combination of an electric discharge mixer device having an inner negative control grid and an outer control grid, a screen structure for said second control grid, a suppressor grid adjacent to the anode and connected with the cathode, said device having a relatively high output impedance, means for selectively connecting each of said signal circuits to said first named control grid, an electric discharge oscillator device having a cathode, an anode, a screen grid, a suppressor grid, and a control grid adjacent to the cathode, a plurality of tunable oscillator circuits, means conjointly operable with said first named connecting means for selectively connecting each of said tunable circuits with the oscillator control grid, means in at least one of said tunable oscillator circuits providing in inductive winding between the cathode and both the anode and the screen grid in common, said winding being grounded at on end, means providing a coupling connection between the cathode of the oscillator and the outer control grid of the mixer device, and means for conjointly tuning said signal and oscillator circuits.

17. In a frequency changer system for high frequency signals and locally generated oscillations, the combination of an electric discharge mixed device having an inner negative control grid and an outer control grid, a screen structure for said second control grid, a suppressor grid adjacent to the anode and connected with the cathode, said device having a relatively high output impedance, means for selectively connecting each of said signal circuits to said first named control grid, an electric discharge oscillator device having a cathode, an anode, a screen grid, a suppressor grid, and a control grid adjacent to the cathode, a plurality of tunable oscillator circuits, means conjointly operable with said first named connecting means for selectively connecting each of said tunable circuits with the oscillator control grid, means in at least one of said tunable oscillator circuits providing an inductive winding between the cathode and both the anode and the screen grid in common, said winding being grounded at one end, means providing a coupling connection between the cathode of the oscillator and the outer control grid of the mixer device, means for conjointly tuning said signal and oscillator circuits, a series resistor in circuit with the screen structure of the mixer device, and means providing a connection between the suppressor grid of the oscillator and said mixer screen, whereby a common operating potential is applied to said electrodes through said last named series resistor.

18. In a radio receiving system, the combination of a detector tube having an inner and an outer control grid, means for applying signals in a plurality of differing frequency ranges to said inner control grid, an electric discharge oscillator device having a cathode coupled to said outer control grid, means for tuning said oscillator through a plurality of correspondingly differing frequency ranges, said means including a tuning inductor having a cathode connection for

the oscillator intermediate its ends, a grid connection for the oscillator at one end, a ground connection at the opposite end, and means for completing said cathode and grid connections for tuning through one of said frequency ranges.

19. In a radio receiving system, the combination of a detector tube having an inner and an outer control grid, means for applying signals in a plurality of differing frequency ranges to said inner control grid, an electric discharge oscillator device having a cathode coupled to said outer control grid, means for tuning said oscillator through a plurality of correspondingly differing frequency ranges, said means including a tuning inductor having a cathode connection for the oscillator intermediate its ends, a grid connection for the oscillator at one end, a ground connection at the opposite end, means for completing said cathode and grid connections for tuning through one of said frequency ranges, and said oscillator having a screen grid and an anode, and means providing an alternating current path between said screen grid and anode with the grounded end of said tuning inductor.

20. In a radio receiving system, the combination of a detector tube having an inner and an outer control grid, means for applying signals in a plurality of differing frequency ranges to said inner control grid, an electric discharge oscillator device having a cathode coupled to said outer control grid, means for tuning said oscillator through a plurality of correspondingly differing frequency ranges, said means including a tuning inductor for one of said tuning ranges having a portion thereof in series between the cathode and ground, said oscillator device being provided with a control grid, a screen grid, a suppressor grid, and a main anode, means providing regulating resistors in series with the screen grid and the main anode, means providing high frequency by-pass connections to the grounded end of the tuning inductor, and means providing a feedback connection with the main anode including a feedback winding, said winding in a predetermined higher frequency tuning band, being tuned below and adjacent to the lowest frequency in said band.

21. In a radio receiving system, the combination of a detector tube having an inner and an outer control grid, means for applying signals in a plurality of differing frequency ranges to said inner control grid, an electric discharge oscillator device having a cathode coupled to said outer control grid, means for tuning said oscillator through a plurality of correspondingly differing frequency ranges, said means including a tuning inductor for one of said tuning ranges having a portion thereof in series between the cathode and ground, said oscillator device being provided with a control grid, a screen grid, a suppressor grid, and a main anode, means providing regulating resistors in series with the screen grid and the main anode, means providing high frequency by-pass connections to the grounded end of the tuning inductor, means providing a feedback connection with the main anode including a feedback winding, said winding in a higher frequency band, being tuned below and adjacent to the lowest frequency in said band, and power supply means for said oscillator connected through said resistors to supply operating current to said oscillator and heating current for the cathode of said oscillator.

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