

Feb. 22, 1944.

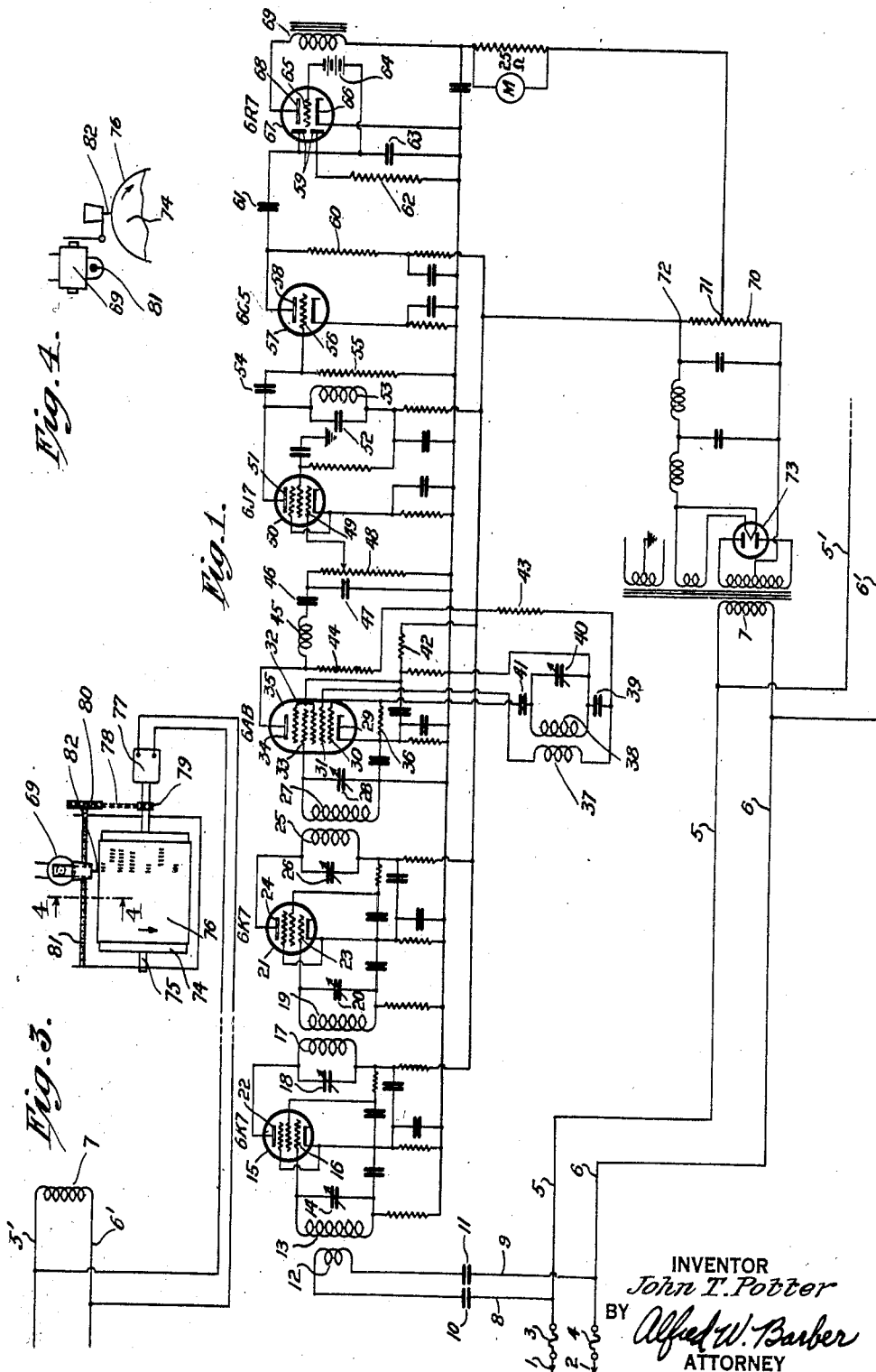
J. T. POTTER

2,342,167

MULTIPLE RADIO RECORDER

Filed Feb. 23, 1939

3 Sheets-Sheet 1



Feb. 22, 1944.

J. T. POTTER

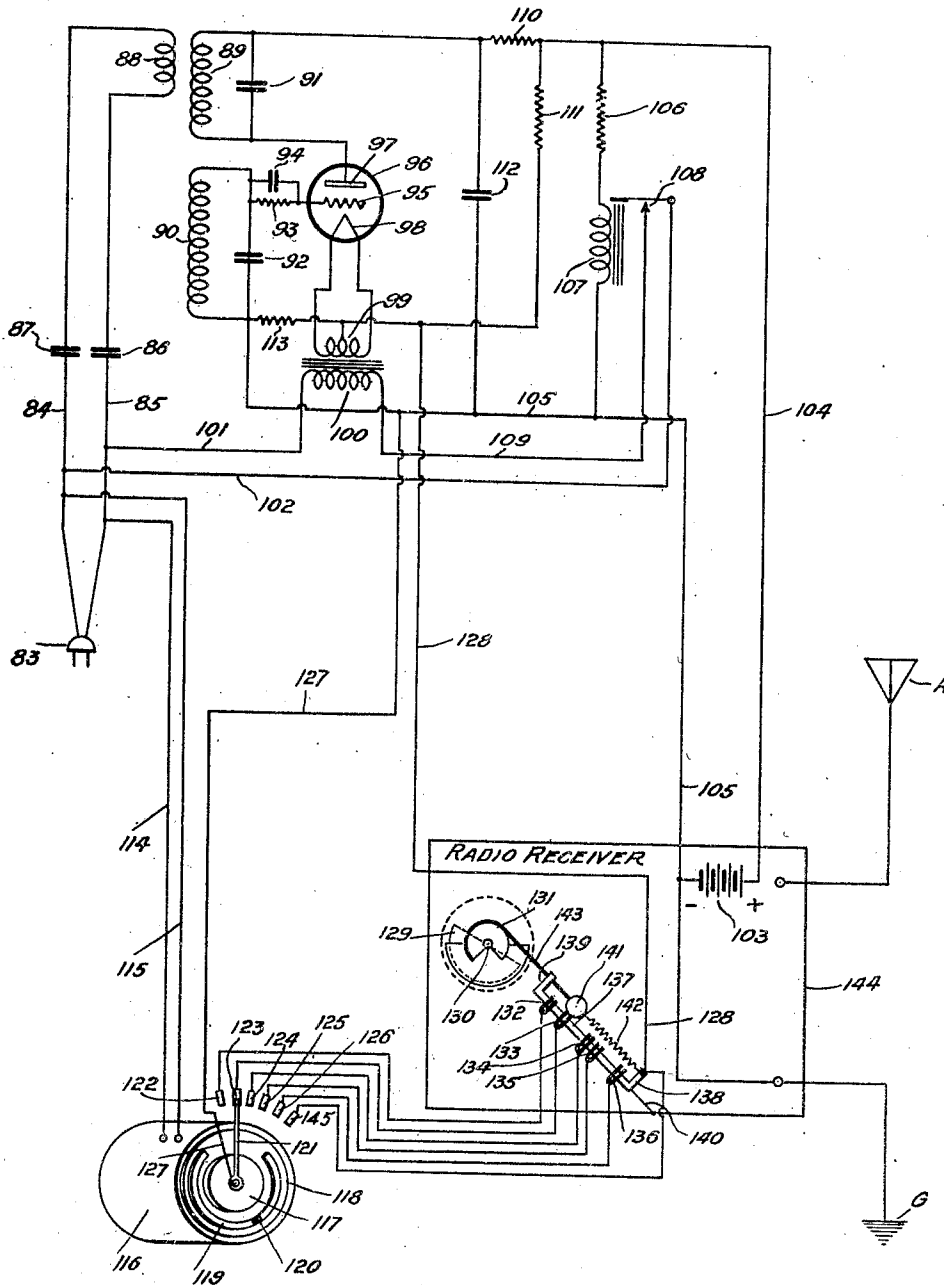
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Fig. 2.



INVENTOR
John T. Potter
BY
Alfred W. Barber
ATTORNEY

Feb. 22, 1944.

J. T. POTTER

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Fig. 5.

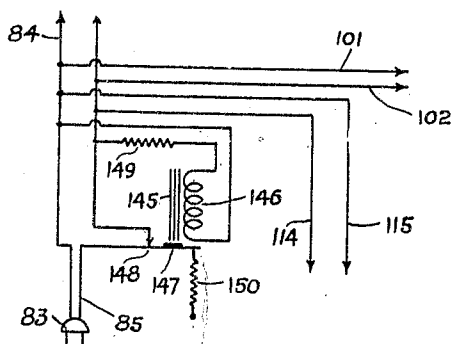


Fig. 6.

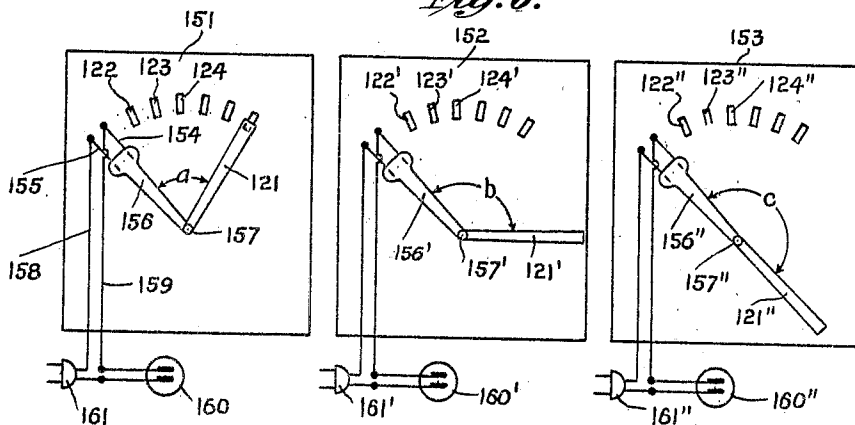
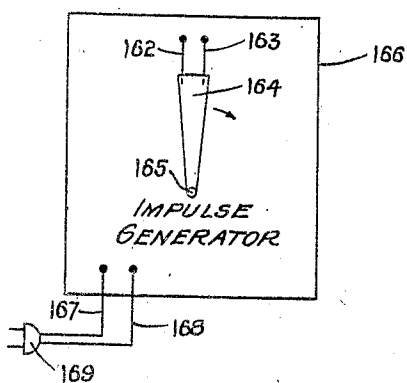


Fig. 7.



INVENTOR
John T. Potter
BY *Alfred W. Barber*
ATTORNEY

UNITED STATES PATENT OFFICE

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MULTIPLE RADIO RECORDER

John T. Potter, Brooklyn, N. Y.

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4 Claims. (Cl. 250—20)

The present invention relates to recorders and in particular to methods of and means for recording the operation of a plurality of radio receivers.

One object of the present invention is to record at a central point and on a single record sheet the tuning and operating conditions of a plurality of radio receivers located at remote points.

Another object is to provide such recording in accordance with spaced impulses of audio or super-audible alternating current voltage where-in the time relations of the impulses indicates the information to be recorded.

A further object is to provide greater sensitivity and selectivity against noise and hence to make greater recording distances possible than hitherto available.

Still another object is to provide an impulse generator to be connected to the radio receiver which sends out an impulse of considerable power over a short interval while requiring only a small input power at any given instant.

Another object is to generate at the radio receiver an impulse of short duration and of a frequency which varies thru a narrow range in order to make useful a high degree of frequency selectivity at the central station and yet permit some drift in average frequency of the generated impulses.

In the copending application entitled "Multiple recorder," now Patent Number 2,249,324, issued July 15, 1941, is shown and described a recorder adapted to record the tuning and operation of a plurality of radio receivers on a single record sheet. At each radio receiver a commutator turns on a fixed frequency oscillator for a short interval which is spaced within a second and longer interval in accordance with the tuning conditions of the receiver. The longer intervals are equal for the various receivers and are phased so that they are consecutive but do not overlap. The longer intervals for all the receivers may add up to a convenient recording time cycle as for instance one minute. At the recorder signals generated by the various radio receiver recorder oscillators are amplified by a fixed frequency amplifier and recorded on a record sheet which is conveniently in the form of a cylinder which makes one revolution per recording cycle. Thus the operation of a particular receiver is recorded in a unique column axially of the cylinder and the reception of a particular station by the receiver is recorded in a line within the column.

The general system employed in the present invention is the same as given above but certain novel improvements have been made. In order to increase the sensitivity of the recorder amplifier in order to permit greater recording distances and also in order to increase the selectivity of the amplifier against noise and other interferences the amplifying is done in two distinct stages at different frequencies. The received signals are first amplified with as much gain and selectivity as is economical and practical and then the signals are heterodyned to a low frequency and again amplified with a large amount of gain and selectivity. The second frequency is chosen as low as possible consistent with the presence of normal amounts of harmonics of the local alternating current power lines and other line noises.

At the radio receivers a substantial improvement has been produced by storing energy during periods between impulses and releasing it in accordance with the information to be recorded. In addition, the frequency of the impulse is varied slightly during generation in order that the high degree of selectivity of the recorder amplifier may be useful in the presence of nominal amounts of drift in average frequency due to temperature and other frequency changing effects.

In the drawings:

Fig. 1 shows a schematic diagram of a recorder embodying the present invention.

Fig. 2 shows a radio receiver impulse generator unit embodying my present invention.

Fig. 3 shows a detail of the recorder.

Fig. 4 shows an additional recorder detail.

Fig. 5 shows a circuit detail.

Fig. 6 shows a method of phasing the receiver units.

Fig. 7 shows an auxiliary impulse generator useful in phasing operations.

Fig. 1 shows a complete central station amplifier and recorder. While other methods of transmission may be used the description will be particularly in connection with transmission of recording signal impulses over alternating current power lines common to the radio receivers and central recording unit. Lines 1 and 2 are connected to the local power lines. Fuses 3 and 4 are provided to protect the apparatus in case of short circuits within it. Wires 5 and 6 go to primary 7 of a conventional power supply transformer for supplying heater current to the various amplifier tubes and direct current for the plates and grids of the tubes and for the record-

ing magnet 69. Branch wires 8 and 9 connect transformer primary 12 to the power line thru blocking condensers 10 and 11. Secondary 13 is coupled to primary 12 and is tuned to the operating frequency of the radio receiver impulse generating units shown in Fig. 2, which may conveniently be of the order of 100 kilocycles. The selected voltages appearing across secondary 13 are applied to grid 16 of pentode amplifier tube 15. The output of tube 15 appearing at its plate 22 is further selected by tuned load circuits 17—18 and the coupled tuned circuit 19—20 all tuned to the same generated frequency. The voltage across coil 19 is applied to the second amplifier tube 21 at its grid 23. Output voltages on plate 24 are again selected by tuned circuits 25—26 and 27—28 and applied to grid 33 of the multigrid converter tube 35. Cathode 29, control grid 30 and anode grid 31 of tube 35 function with transformer 37—38 tuned by condenser 40 to produce heterodyning oscillations at a desired difference frequency with said generated frequency as for instance 95 kilocycles. The 5 kilocycle difference frequency appears at plate 34 and across plate load resistor 44. Since the 95 and 100 kilocycle voltages are no longer desired they are eliminated by means of the filter composed of choke 45 and condenser 47. The 5-kilocycle voltage to be further amplified and utilized to operate the recorder is applied to grid 49 of amplifier tube 50 by means of a tap on volume control 43 thru blocking condenser 46. The amplified 5 kilocycle signal on plate 51 is made large by loading plate 51 with inductance 53 tuned to 5 kilocycles by means of condenser 52. The signal voltage across inductance 53 is applied to grid 56 of amplifier tube 57 thru blocking condenser 54 and across grid resistor 55. Amplifier tube 57 is a triode particularly suited to operate a diode rectifier. The amplified signal on plate 58 loaded by resistor 60 is applied to a diode rectifier consisting of plates 59 and cathode 66 of diode-triode tube 67 thru blocking condenser 61. A diode load is provided in resistor 62 by-passed by condenser 63. Rectified direct current impulses thus generated are applied to control grid 65 thru grid bias battery 64. Amplified direct current at plate 68 is passed thru magnet 69 of the recorder unit and thus operates pen 82. The recorder consists in cylindrical drum 74 covered by a record sheet 76 mounted on a shaft 75 and driven by synchronous motor 77. Motor 77 is operated from the same alternating current source as the radio receiver signal generating units in order to provide synchronous operation. Magnet 69 is moved along the recorder drum by the lead screw 81 driven from sprocket 80 by chain 73 and a second sprocket 79 on motor shaft 75. Motor 77 includes suitable reducing gears to produce a speed of shaft 75 of the order of one revolution per minute. Sprockets 79 and 80 are proportioned so that with a properly chosen pitch in lead screw 81 magnet 69 is caused to traverse the drum in a suitable time as for instance 24 hours. In order to produce an equal marking intensity regardless of the strength of received signals pen 82 is operated by gravity. Plate current in tube 67 is adjusted by proper choice of bias battery 64 voltage so that magnet 69 is energized and pen 82 is kept off of the record sheet in the absence of received signals. Received signals are rectified and applied to grid 65 as negative impulses causing magnet 69 to release allowing pen 82 to contact record sheet 76. Control 43 is used to set the recording level above the noise level.

In Fig. 2 is shown a circuit diagram of an impulse generating unit suitable for attachment to a radio receiver for generating impulses indicating the operation and tuning conditions of the receiver to be recorded at the above described central or recording station. The impulse generator comprises a thermionic vacuum tube oscillator and a motor driven contactor sweeping over a commutator connected to a multi-point switch associated with the radio receiver tuning mechanism. The oscillator circuit utilizes a vacuum tube 95 having a cathode 98, control grid 95 and plate 97. This tube is connected to an oscillatory circuit made up of grid coil 90 tuned by condenser 92, plate coil 89 coupled to grid coil 90 and tuned by condenser 91, and grid resistor 93 by-passed by grid condenser 94. This constitutes a feedback oscillator with grid and plate tuning. Oscillator voltage impulses are fed to the local power line by means of coil 88 coupled to plate coil 89, blocking condensers 87—86 and line plug 83. Cathode 98 is energized from the filament transformer secondary 99 the primary 100 of which is also supplied from the power line thru leads 101, 102 and 109 and relay contact 108, so that tube 96 is operable only when relay 107—108 is closed. Plate voltage for tube 96 is supplied from condenser 112 which is charged thru resistor 110 from the high voltage direct current source 103 of the "radio receiver" 144 being monitored thru lead 104. Oscillator tube 96 is rendered inoperative further by plate current cut-off bias applied to heater source 99 from resistor 111 and through resistor 113. Resistors 111 and 113 are proportioned to keep plate current to tube 96 substantially cut-off or at least small enough so that the tube 96 does not oscillate. Resistor 113 is shorted at intervals in a manner to be described thus removing the cut-off bias from tube 96 and causing it to oscillate strongly dissipating the charge in condenser 112. Between intervals condenser 112 recharges thru resistor 110 to essentially the voltage of source 103. Since the periods of oscillation are very short compared to the periods between oscillation the average charging current drawn from source 103 may be made small compared to the current drawn for the short oscillation intervals from condenser 112. As an example the intervals between impulses may be 100 times the periods of the impulses and tube 96 may draw 100 milliamperes during the oscillation periods while drawing only 1 milliampere from source 103. This provides efficient operation and permits operation of a powerful oscillator from a small capacity power supply without disturbing the normal operation of the power supply.

Radio receiver 144 is to be monitored. It is connected to antenna A and ground G or other suitable energy collecting means. While other types of tuning mechanism may be monitored, for purposes of explanation a variable tuning condenser 129 is shown in receiver 144. On the shaft 130 of condenser 129 is connected a segment of a pulley 131. To pulley 131 is connected a monitoring switch comprising a central support rod 137, adjustable contacts 132, 133, 134, 135 and 136, a variable contactor ball 141 pulled by wire or string 143 connected to pulley 131 and returned by spring 142 which also serves as an electrical connection between contactor 141 and common output lead 128. The switch also includes end supports 138 and 139 and anchor wire or string 140 for restraining longitudinal motion of the switch. Wire or string 140 may be fastened

to a suitable and convenient point of the chassis or cabinet of 144 so that the switch body is held in a line substantially tangent with pulley 131. Contacts 132, 133, 134, 135 and 136 are adjusted on a particular receiver so that as condenser 129 is tuned contactor 141 makes contact with them at condenser settings corresponding to radio stations which are to be recorded.

Timed impulses are generated by means of a motor driven commutator operated in connection with the switch and oscillator described above. The commutator comprises commutator points 122, 123, 124, 125 and 126 connected to switch points 132, 133, 134, 135 and 136 respectively; motor driven commutator arm 121; and synchronous motor 116 connected to the power line by means of leads 114 and 115 and line plug 83. Arm 121 is driven at a convenient speed as for instance one revolution per minute thru reduction gear box 117. Gear box 117 is mounted on a plate 118 having a semi-circular slot 119 and the said plate is clamped to motor 116 by means of screw 120. The phase relation of arm 121 with respect to the alternating current power line voltage may be adjusted by releasing screw 120, turning plate 118 to a desired position and replacing screw 120. Commutator segments 122 to 126 inclusive are equally spaced and occupy a predetermined angle as for instance six degrees. As arm 121 rotates it completes a circuit thru the receiver condenser operated switch and leads 127 and 128 corresponding to the position of contactor 141 and hence condenser 129 and the time and phase relation of arm 121 shorting cut-off bias producing resistor 113 and causing tube 96 to oscillate feeding an impulse of oscillator voltage to the power line. The additional commutator point 145 is connected to the common switch lead 128 so that at each rotation of the commutator arm 121 a signal is generated indicating that the radio receiver is turned on whether or not one of the preselected stations is tuned in.

The operation of a system including a number of receivers will now be described. A particular receiver 144 is turned on by a listener. When the receiver has warmed up voltage appears in source 103 energizing relay coil 107 closing contact 108 and thus energizing filament or heater 98 of tube 96. At the same time condenser 112 starts to charge thru resistor 110 until it reaches the voltage of source 103. Motor 116 is operated continuously and every minute sweeps contacts 122 to 126 inclusive with arm 121. If receiver 144 is tuned to a station the reception of which is to be recorded one of these commutator points 122 to 126 is energized thru contact 141 and one of the contacts 132 to 136 inclusive. When arm 121 contacts an energized segment, resistor 113 is shorted and an impulse of oscillator voltage is applied to the power line. This impulse is received at the central station and recorded on the record sheet by the central station amplifier and recorder described above. While tube 96 is oscillating, it is drawing a heavy current from condenser 112 causing the voltage across it to fall. This falling voltage causes the oscillator frequency to vary slightly. For instance, a central station may be tuned accurately to 100 kilocycles while the oscillator may oscillate from 99 to 101 kilocycles. It will be seen that the mean frequency may vary plus or minus 1 kilocycle and it will still pass thru 100 kilocycles while it is being impulsed. This frequency variation permits a high degree of selectivity to be used in

the central unit and a variation of the oscillator mean frequency and still proper recording of the signal will be accomplished.

With the commutator segments occupying six degrees, for instance, sixty receiver units may be operated into a single recorder without overlap by phasing the receiver impulse generating units to be complementary in time spacing. This spacing and mode of operation is more particularly described in the co-pending application cited above.

In a radio receiver recording system, such as the one herein described, it is important that further recording be prevented in case of momentary power failure since in general such failure will destroy the proper phase relations between the receiver units and the central station recorder. Fig. 5 shows a relay 145-146-147-148-150 which is interposed between the power source wires 84-85 and the leads 101-102 and 114-115 going to the oscillator tube filament transformer 99-100 and the commutator motor 116 respectively. This relay is designed to close contact 148 energizing the oscillator and motor as long as the power is uninterrupted but opens and stays open until reset in case of temporary power failure. From power supplied through the current limiting resistor 149 relay coil 146 energizes core 145, attracting armature 147 against spring 150, thus closing contact 148.

Fig. 6 shows a method of phasing the various receiver units. An impulse is transmitted once for each revolution of the commutator arms 121, 121', 121'' etc. by apparatus as in Fig. 7. This impulse is picked up and the operator listens to it in a pair of earphones. Each receiver unit is provided with an auxiliary arm 156, 156', 156'' etc., each phased by a different angle with the main commutator arms 121, 121', 121'' etc. The difference angles α , β , γ , etc., differ by the angle α subtended by the commutator contacts 122, 123, 124, etc. The auxiliary commutator arm is adapted to short a pair of contacts 154-155 in each unit completing a circuit thru leads 158-159 and line plug 161 to a neon lamp 160. Each receiver unit is phased until the neon lamp 160 flashes in synchronism with the impulses received in the earphones. When all the units are so phased, they will operate at the relative phase angles determined by the auxiliary arms 156, 156', 156'', etc., which have been predetermined to be the desired phasing angles.

Fig. 7 shows an impulse generator 163 having a single synchronously driven commutator arm 164 driven at the same rate as arms 121, 121', 121'' etc. Arm 164 shorts contacts 162-163 and by turning on an oscillator or other suitable means, sends the phasing pulse over the power line by means of wires 167-168 and line plug 169. This phasing pulse is generated while the various receiver units are being set up and phased or in case of power failure for rephasing purposes and is turned off while recordings are being made.

While one embodiment of this invention has been shown and described, it is intended to limit it only in accordance with the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In a radio receiver tuning condition and operation determining system, the combination of, a selector switch adapted for selective operation in response to the tuning condition of the radio receiver, a normally inoperative oscillator, a motor driven commutator for rendering said

oscillator operable in accordance with the position of said selector switch, and a condenser and resistor connected to said radio receiver and receiving current therefrom for storing energy at a substantially constant rate to provide power for energizing said oscillator during its periods of operation.

2. In a radio receiver tuning condition and operation determining system, the combination of, a selector switch adapted for operation in response to the operation and tuning of the radio receiver, a normally inoperative oscillator, a motor driven commutator for rendering said oscillator operable in accordance with the position of said selector switch, a condenser for continuously storing energy for energizing said oscillator during its periods of operation, a source of direct current within said radio receiver, and a resistor connected between said source and said condenser for limiting the current supplied to said condenser.

3. In a radio receiver tuning condition and operation determining system, the combination of, a multi-point switch adapted for operation in response to predetermined tuning conditions of said radio receiver, a normally inoperative oscillator, means for rendering said oscillator operable at predetermined time intervals in accordance with the position of said multi-point switch, means for deriving electrical energy from the radio receiver, means for storing said energy for energizing said oscillator during the time of inoperativeness of said oscillator, and means for releasing said stored energy during intervals of operativeness of said oscillator.

4. The system as claimed in claim 1, and means for rapidly varying the frequency of said oscillator through a selected frequency.

JOHN T. POTTER.