June 22, 1937. A. A. LINSELL 2,084,586

RADIO TUNING ARRANGEMENT

Filed June 28, 1933 2 Sheets-Sheet 1

Fig. 1

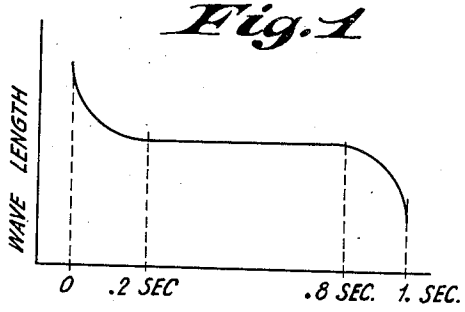


Fig. 2

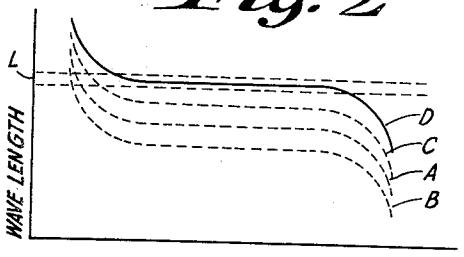


Fig. 3

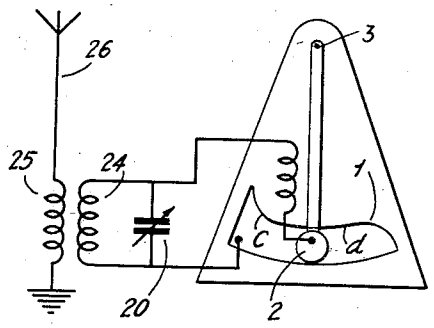


Fig. 4

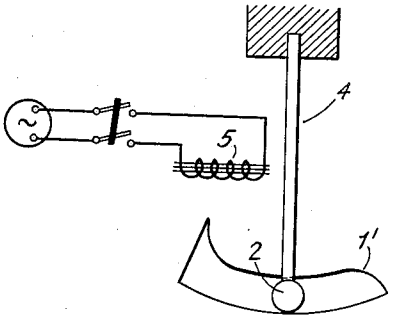


Fig. 6

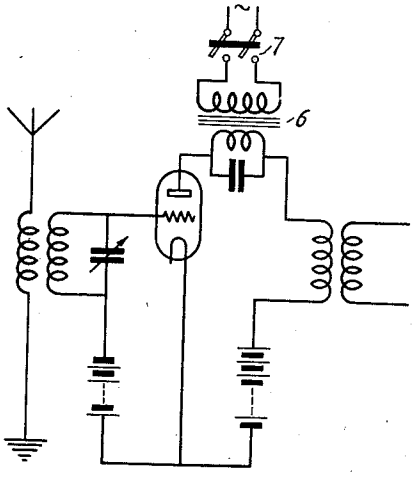
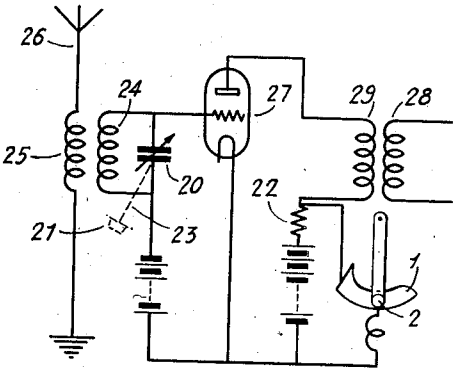


Fig. 5



INVENTOR
ALFRED AUBYN LINSELL
BY H. S. Grover
ATTORNEY

June 22, 1937. A. A. LINSELL 2,084,586

RADIO TUNING ARRANGEMENT

Filed June 28, 1933 2 Sheets-Sheet 2

Fig. 7

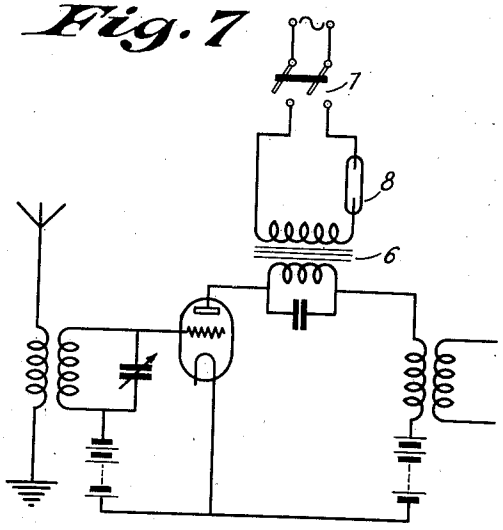


Fig. 10

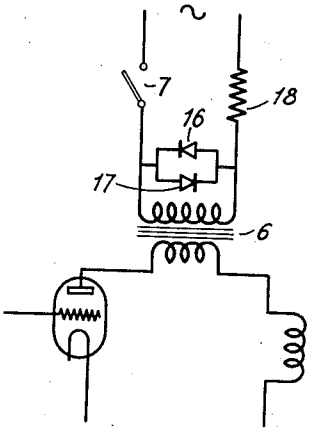


Fig. 8

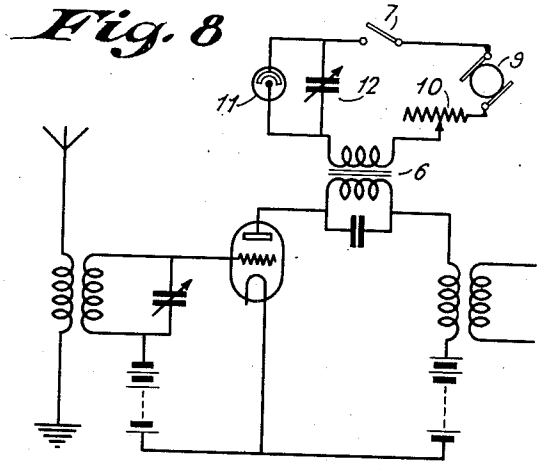


Fig. 11

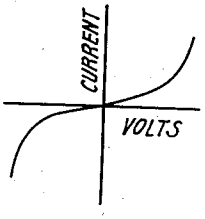
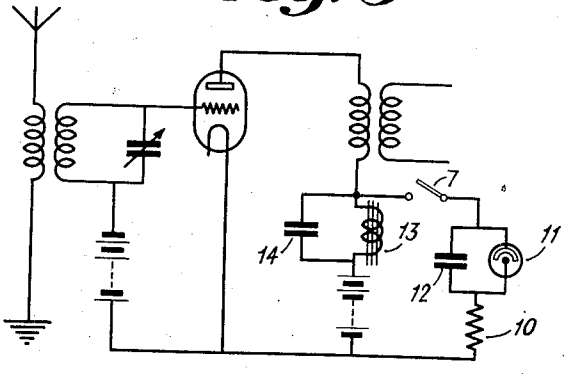


Fig. 9



INVENTOR
ALFRED AUBYN LINSELL
BY H. S. Grover
ATTORNEY

Patented June 22, 1937 2,084,586

UNITED STATES PATENT OFFICE

2,084,586

RADIO TUNING ARRANGEMENT

Alfred Aubyn Linsell, London, England, assignor to Radio Corporation of America, a corporation of Delaware

Application June 28, 1933, Serial No. 677,967. In Great Britain July 4, 1932

7 Claims. (Cl. 250—40)

This invention relates to tuning arrangements for use in radio reception and transmission and more particularly, though not exclusively, to arrangements for tuning receivers working on very short wave lengths, and other receivers where very sharp and critical tuning is employed. It is well known that owing to the critical nature of the tuning for most very short wave receivers considerable difficulty is met with in endeavoring to pick up short wave stations, possibly because the hand in turning the tuning device, usually a variable condenser, tends to rotate it in jerks and may accordingly, even when the greatest care is employed in tuning, rotate the tuning condenser past the position in which a desired station will be picked up.

The present invention has for an object to avoid this difficulty.

It has previously been proposed to provide the tuning circuit of an apparatus for wireless telegraphy with a variable inductance and/or a capacity having a movable part capable of mechanical oscillation, as, for example, a rotating part fitted with a spring like the balance wheel of a watch, the purpose being to facilitate wireless telegraphic communication between two stations and to provide means whereby the attention of a listening operator could be directed to enable him to tune the receiver rapidly to the transmitter.

The present invention provides arrangements suitable for use in overcoming the practical operating difficulties which arise where a receiver tuning is so very critical that, as stated, the hand may easily move the tuning device from a position on one side of that which is the correct position for receiving the desired station to a position on the other side, despite a reasonably careful attempt to move the tuning device less than this quite small distance.

Several embodiments of my invention are shown in the accompanying drawings in which,

Figs. 1 and 2 show tuning curves obtained with a tuner made according to the invention;

Figs. 3, 4, and 5 show different schematic arrangments of the auxiliary tuning means;

Figs. 6 to 10 show other embodiments of the invention; and,

Fig. 11 shows the preferred rectifier characteristic of the rectifiers employed in the circuit arrangement of Fig. 10.

According to this invention, a short wave or other very critically tuned radio receiver is provided with means for automatically varying the tuning of the receiver in a continuous periodic manner during tuning i. e. while the actual adjustment is being made, the arrangement being such that the tuning remains substantially constant for a substantial portion of each period or cycle of tuning variation. Preferably, in carrying out the invention, the tuning is maintained constant for about 60% of the time occupied by one complete cycle of tuning variation, while for 20% of this time the wave length is increased and for the remaining 20% of this time the wave length is decreased. An additional advantage is obtained by so arranging matters that the rate of change of wave length decreases as the time per cycle at which no change occurs is approached and similarly increases as this time is left although of course such arrangement is not an essential feature of the invention. To put the matter in another way, it is preferred where practicable to arrange for the curve of wave length (ordinates) against time (abscissae) over one cycle of wave length variation to be a curve as shown in the accompanying Figure 1 consisting of a portion which begins by moving substantially vertically downwards and then gradually flattens out into a flat horizontal portion the flat horizontal portion being succeeded by a portion which slopes increasingly downwards. For example, where the whole cycle occupies one second the period 0 to .2 of a second may be occupied by the first downward sloping portion, the period .2 to .8 of a second be occupied by the flat horizontal portion and the period .8 to 1 second be occupied by the succeeding downward sloping portion.

The avantage of this arrangement is that as the receiver is more and more nearly correctly tuned i. e. as the manually adjusting means is more and more accurately moved to the position at which the wave length obtained will be that given over the major portion of the cycle of tuning variation, the time during which the desired station will be properly received will be increased. This advantage is represented graphically in the accompanying Figure 2 in which the curves A, B, C, and D are those obtained with four different settings of the manual adjusting means. If the station to be received is of wave length L the full line curve (the curve D) is that obtained when the manual adjustment is correct for receiving this station. In Figure 2 the broken horizontal lines represent the upper and lower limits of the portion of the wave length spectrum occupied by the station whose carrier wave length is L. The actual amount of tuning variation obtained will, of course, depend upon circumstances, but as an example a variation of + or —1000 kilocycles would be convenient for a case in which the station desired to be received operated on 10 metres i. e. at 30,000 kilocycles.

The invention may be carried into effect in numerous ways illustrated with the aid of the accompanying drawings.

In one way of carrying out the invention there is provided in association with the normal manually adjustable tuning condenser **20**, for example in shunt therewith, an automatically cycli-

cally varying condenser illustrated in Figure 3 and which consists of two electrodes 1, 2, the former being a specially shaped fixed electrode and the latter a movable electrode mounted close to 1 which is suspended after the manner of the bob weight of a pendulum about a pivotal axis 3 in such manner that it may swing to and fro opposite and adjacent to the fixed electrode. The fixed electrode has parallel arcuate sides for most of its length i. e. the length *c—d* (the arcuate sides are concentric and have as centre the axis 3) but towards one end, for example over 20% of its length, one side curves increasingly in a direction towards the other side so that this end of the fixed electrode is bounded by one side curving over to the other while towards the other end one side surves increasingly away from the other, this other end of the electrode being bounded by an end edge which joins the increasingly divergent sides together.

The two ends of the electrode are specially formed in this way so as to give the desired shape of periodic wave length variation curve above described, since the capacity given by the auxiliary condenser will be constant so long as the moving electrode 2 is swinging over that portion *c—d* of the fixed electrode which is parallel sided. When the radio receiver is being tuned to a station the pendulum is set swinging in any convenient way, for example by hand or automatically, and it is stopped when the desired station is properly tuned in.

In a modification (illustrated in Figure 4) of the above described construction the swinging pendulum is replaced by a reed-like member 4 which as before carries a movable electrode 2 which reciprocates back and forth in a specially shaped slot 1' in a fixed electrode. The reed is set in vibration in any convenient way, for example, if alternating current is available the reed may be (in conjunction with the moving electrode) arranged to be of a natural frequency corresponding to the alternating current available and may be vibrated electro-magnetically by a coil 5 fed with alternating current after the manner of the reed of a frequency meter. Where alternating current is not available direct current may be employed and the reed be fitted with a make and break device so that it reciprocates after the manner of the armature of an electrical bell. Again the reed may, if desired, be driven by energy derived from a so-called neon tube "blink" circuit. In the construction shown, the reed will vibrate at fairly low audio frequencies.

In many short wave receivers variation of tuning may be affected by variation of the impedance in the high tension anode supply circuit and accordingly, in many cases, it is possible to carry out the present invention by connecting the automatically varying condenser above described for example in shunt across the high tension battery of a receiver instead of conductively with the ordinary tuning condenser. Normally a small resistance 22 connected in series with the anode battery will be necessary and the automatically varying condenser may be connected in shunt across the series connected resistance and battery instead of across the battery alone. Such an arrangement is shown in Figure 5.

In Figs. 3 to 10 the main tuning condenser 20 is shown to consist of the usual set of rotary plates connected by a shaft 23 to the operating knob 21. The condenser is shown connected across the secondary coil 24 of a radio frequency transformer having a primary 25 connected in the antenna circuit 26. As shown, one side of the main tuning condenser 20 is connected to the grid of a radio frequency amplifier tube 27, the other side being connected to the tube cathode. The output circuit of the tube may be connected to the secondary 28 of a radio frequency transformer whose primary 29 is in the plate circuit. It will be understood that the operator of the set adjusts knob 21 to tune in the desired station while the auxiliary condenser 1—2 is in operation.

In a further way of carrying out the invention illustrated in Figure 6 an automatically varying condenser is not employed and instead alternating current of appropriate wave shape is superimposed in the plate circuit of a valve in the receiver so as to alter the effective tuning of the receiver as a whole. The super-imposed alternating current may be applied, as shown in Figure 6, by means of a transformer 6 having its secondary connected in the plate circuit of a valve or it may be supplied by any convenient form of buzzer or make and break device or a so-called neon tube "blink" circuit may be employed.

In one arrangement of this kind illustrated in Figure 7 the secondary of a transformer 6 shunted by a condenser as shown is inserted in the plate circuit of the first valve of the receiver, the primary of the transformer being connected in series with a neon lamp 8 and a switch 7 to a source of alternating current potential. The striking voltage of the neon lamp is so chosen in relation to the available alternating current potential that the wave form set up in the secondary of the transformer is of the desired character, namely substantially flat over a substantial period per cycle. If desired, additional inductance or resistance shunted by capacity may be employed in the transformer primary circuit to produce the desired wave shape. In the arrangements of both Figures 6 and 7 the switch 7 is opened after a station has been properly tuned in, but is closed for the tuning operation.

In a modification illustrated in Figure 8 of the last described arrangement the primary of the transformer 6 is connected in series with a variable resistance 10, a direct current source 9, a switch or key 7 and a neon lamp 11 shunted by a variable condenser 12 in a loop circuit while in yet another modification illustrated in Figure 9 the transformer 6 of Figure 8 is replaced by a choke 13 shunted by a capacity 14 which is inserted in the anode feed to the valve and adjacent the anode battery, a circuit consisting of a switch or key 7 a capacity 12 shunted neon lamp combination 11—12 and a resistance 10 being bridged across the series connected anode battery and capacity shunted choke combination 13, 14.

In yet a further modification illustrated in Figure 10 in which a transformer 6 having its secondary inserted in the plate circuit of a receiver valve is employed, the primary of the transformer is connected in series with a switch or key 7 and resistance 18 to a source of alternating current and is bridged by a circuit consisting of two rectifiers 16—17 for example crystal detectors, in parallel with one another but so arranged that one of the rectifiers rectifies the positive half wave and the other the negative. Alternatively the rectifiers in shunt with one another may be connected in series with the source of alternating current and the resistance dispensed with. The rectifier characteristics should be (as shown graphically in Figure 11) such that the normally applied approximately sine wave alternating current is transformed into a wave shape as required

for carrying out the present invention. The arrangement should be such that the rectifiers may be effectively cut out of circuit (i. e. open circuited or short circuited according to the general circuit arrangement employed) when the tuning operation is finished so that there is no possibility of the ordinary receiving action of the receiver being disturbed or interfered with by reason of anything occurring in the rectifiers.

Rectifiers having suitable characteristics are the well known carborundum crystals and said crystals are quite stable over long periods and require no attention.

In another simple modification (not illustrated) wherein a transformer having its secondary inserted in the plate circuit of a receiver valve is employed, the primary of the transformer is simply energized by alternating current of ordinary sine wave form, but the transformer is so designed that the core begins to operate in saturated condition for primary amplitudes less than the peak value of the applied A. C.; e. g. the core may be arranged to saturate at a primary voltage of about 25% of the peak value of the applied A. C. so that the secondary voltage remains substantially constant for a substantial period in each half cycle.

The present invention, although above described with particular reference to radio receivers for modulated or unmodulated carrier waves is not limited to radio receivers, but the methods of frequency or wave length variation herein described are applicable also to radio transmitters. For example, at the present time transmitting stations of the British Broadcasting Corporation send out a so-called tuning note for enabling receivers to be tuned to those stations but with radio transmitters operating on the shorter wave lengths it may be found convenient, not merely to send out an audio modulation tuning note as is the present practice, but also to vary the carrier frequency itself during the so-called tuning interval preceding the programme and the present invention is obviously applicable for causing such variations in the emitted frequency of a radio transmitter.

I claim:

1. In combination in a device of the class described, a circuit to be resonated to a predetermined frequency, including an adjustable condenser therein, a control knob connected to said condenser, an auxiliary tuning element coupled to said condenser and means mechanically independent of said control knob arranged to adjust said auxiliary tuning element periodically to a predetermined constant value for a substantial time interval and alternating to values greater and less than said predetermined value for shorter time intervals.

2. In a tuning arrangement, the combination of a circuit to be resonated to a given frequency comprising a coil and a variable condenser, means for adjusting said condenser, a second condenser having a fixed electrode and a movable electrode, said fixed electrode having a central portion bounded on its opposite sides by concentric arcs and having non-concentric end portions, means for reciprocating said movable electrode adjacent said fixed electrode and connections between the electrodes of said two condensers.

3. In a tuning arrangement, the combination of a circuit to be resonated to a given frequency comprising a coil and a variable condenser, a second variable condenser having its terminals connected to those of said first named condenser, said second condenser comprising a pendulum, a movable electrode secured to the end of said pendulum, a fixed electrode located adjacent said movable electrode, and having at least a portion of its oppositely disposed edges formed of circular arcs whose center of curvature is the axis of oscillation of said pendulum.

4. In a tuning arrangement, the combination of a circuit comprising a coil and a variable condenser, means for adjusting said condenser to resonate said circuit to a predetermined frequency, a second condenser connected to said circuit and comprising a movable and a fixed electrode, one of said electrodes having a central portion so shaped as to maintain said circuit resonant at the predetermined frequency while the movable electrode is moved over more than half its range of movement and having one end portion shaped to increase said resonant frequency and its opposite end portion so shaped as to decrease said resonant frequency below said predetermined frequency.

5. In a tuning arrangement, the combination of a circuit comprising a coil and a variable condenser, means for adjusting said condenser to resonate said circuit to a predetermined frequency, a second condenser connected to said circuit comprising a fixed electrode, a vibratile reed, a movable electrode carried by said reed adjacent said fixed electrode, said electrodes being so shaped as to maintain said circuit resonant at said predetermined frequency while the reed is moving over a substantial angle on each side of its central position and electro-magnetic means for vibrating said reed.

6. In a tuning device, the combination of a circuit to be resonated to a predetermined frequency and comprising inductive and capacitive reactances, means for adjusting one of said reactances, a condenser having a fixed electrode and a movable electrode, connections between said electrodes and said circuit, one of said electrodes having a central portion bounded on its opposite sides by concentric arcs and having one end portion of increasing area and an opposite end portion of decreasing area and means for reciprocating said movable electrode adjacent said fixed electrode.

7. In a tunable amplifying device the combination of a vacuum tube having a cathode, grid and plate, a grid circuit connecting said cathode and grid, means for tuning said grid circuit to a predetermined radio frequency, a plate circuit connected between said cathode and plate and including a source of direct current and resistor connected in series, a condenser having a fixed electrode and a movable electrode, leads connecting said electrodes to the outer ends of said current source and resistor respectively, means for reciprocating said movable electrode adjacent said fixed electrode, one of said electrodes having a central portion so shaped as to maintain said grid circuit resonant at said predetermined frequency over at least half the range of movement of said movable electrode.

ALFRED AUBYN LINSELL.