Oct. 21, 1941. W. J. POLYDOROFF 2,260,088

RADIO TUNING ARRANGEMENT

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FIG. 1

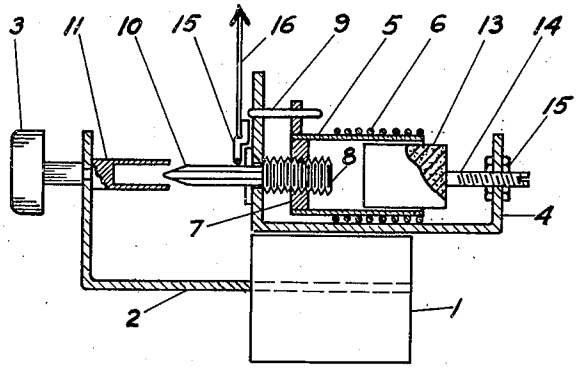


FIG. 2

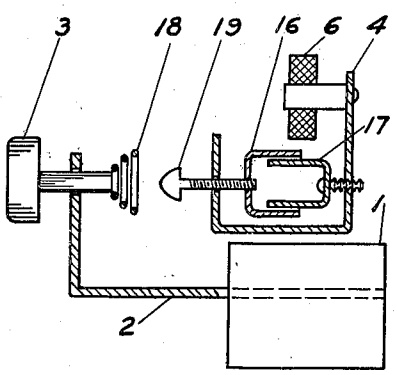
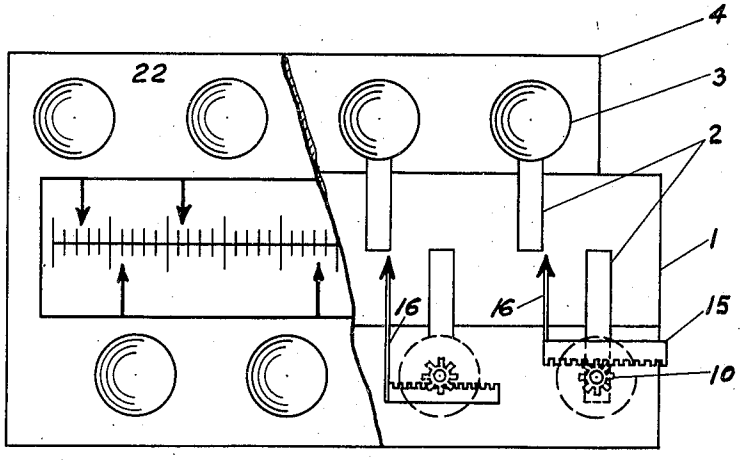


FIG. 3



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Fig 4

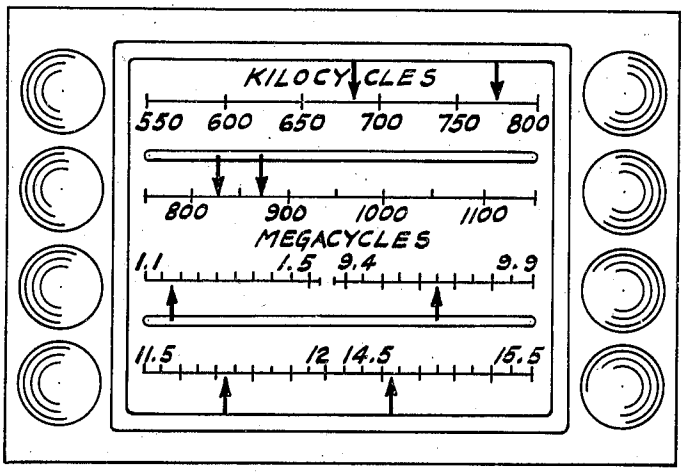
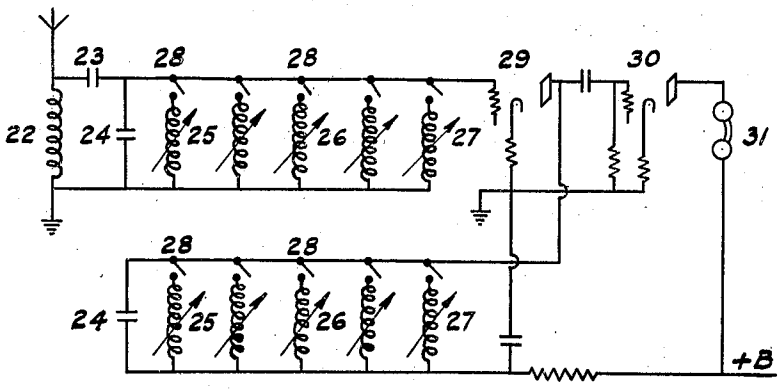


FIG. 5



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FIG. 7

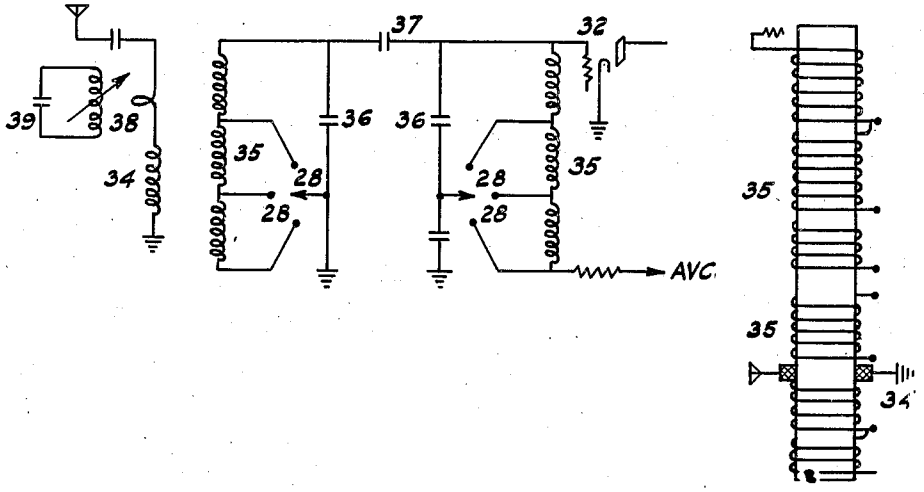
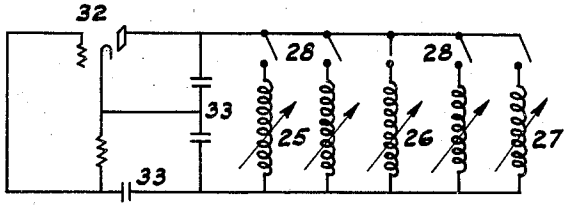


FIG. 6



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UNITED STATES PATENT OFFICE

2,260,088

RADIO TUNING ARRANGEMENT

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Application June 19, 1939, Serial No. 279,894
In Great Britain July 12, 1938

3 Claims. (Cl. 250—40)

The invention relates to tuning arrangements for radio receivers in which a desired station can be selected and tuned in, either by the switching in of pre-tuned circuits or by continuous tuning of said circuits. The invention provides novel and convenient tuning and switching means which have great convenience of operation together with abolishing of usually employed tuning means.

It is already known how to operate a radio receiver in a manner such that several preferred stations in the broadcast range can be brought in by a push button mechanism. Such existing systems either employ complicated mechanical selector devices operating on the tuning controls, or a plurality of electrically pre-set groups of circuits, each group responsive to the frequency of a desired station. The first described system lacks the required precision when the tuning mechanism is directly operated by mechanical means, and in order to increase the accuracy, costly electric motors are often employed. The second system requires duplication of tuning equipment in order to also provide continuous tuning. The choice of pre-set stations varies with localities. This is particularly important in mobile receivers (automobile or portable) and a frequent re-adjustment of station settings may be required, the mechanism for which in present systems is not readily accessible to the operator. Unless a complicated automatic frequency control circuit is employed in the receiver, these pre-settings may require correction, as the receiver may drift in frequency with temperature and power fluctuations, otherwise de-tuning and distortion occur.

The present invention describes a new and improved tuning arrangement and method of tuning in which the above described defects are eliminated. The invention is applicable to circuits tuned by either variable inductance or variable capacity or both of such types in which a rotation of a knob produces the changes of electrical quantity governing the frequency adjustment and which can be easily calibrated. To this type belong inductances tunable by magnet core, movable linearly or rotating in a semi-spherical winding, revolving coils with sliding contact and rotary condensers having two concentric caps closing the gap and movable short circuiting ring.

The main object of the invention is to provide a compact and readily adjustable arrangement of tuning parts which permit the selection of pre-set stations as well as continuous tuning, without the employment of the usual variable condenser or inductance units ganged together.

Another object is to provide a convenient and novel tuning indicator in connection with the adjustable circuits which enables the operator to instantaneously select or change at will the desired stations by simple means.

Still another object is to provide an arrangement of electrical circuits and their constants so as to derive the benefits of the invention in several possible applications of the system to various frequency bands encountered in a radio receiver.

The invention will be better understood if reference is made to the accompanying drawings in which:

Fig. 1 shows one section of the tuning unit.

Fig. 2 shows a modification of this unit.

Fig. 3 is the front view of one of the above units with its dialing indicator, and Figure 4 its modification.

Figs. 5, 6, and 7 show the electrical circuit arrangements. According to the invention, each present conventional frequency band of the receiver is subdivided into several part-ranges, which sub-ranges may be in duplicate, and are continuously tunable either in every separate circuit or by having certain circuits permanently adjusted to respond to the whole part-range.

Accordingly, the tuning ratio (ratio of LC of each tunable circuit) is considerably reduced and a band spread is obtained. This is particularly needed in short wave tuning, where a crowding of stations occurs over certain small regions of the entire "short wave" band. The following example illustrates the normal and novel tuning ratio requirements:

The conventional broadcast band used in this country at the present time normally requires a tuning ratio of 8.5 in order to cover the band of frequencies from 540 to 1560 kc.

This band may be divided into three part-ranges, which with a slight overlap may be as follows: 545–800; 750–1150; 1100–1560 kc. In each of said part ranges the tuning ratio is approximately 2.2; if a superheterodyne circuit is employed with a standard I. F. 450 kc. the tuning ratio of the oscillator circuit for the above part-ranges is approximately 1.8; in the short wave region the desired part-ranges in which the stations are allocated are still smaller, so that the tuning ratio becomes from 1.2 to 1.4 for all these circuits.

It is therefore convenient to employ the variable elements of the circuits of a different compact design which will answer the requirements of reduced tuning ratio. It is also convenient to make the mechanism selecting the desired part-range and its tunable circuits into one unit, which essentially will consist of a push-button operated switch, assembled with its circuits, tuning elements and the dial indicator means. In order to save on parts and space the same operating parts may perform the two functions of tuning and selecting the ranges.

Fig. 1 shows one such arrangement of the new tuning device. A push-button switch is represented by 1. The switch may be made of several sections, depending on how many sub-ranges and station selectors are required. Thus in the above example of subdivision of the broadcast range into three ranges, it may be desirable to have two "pre-set" or tunable channels in each sub-range in which case a six section switch will be used. If, in addition, three or four short wave "spread-tuned" sub-ranges will be used the switch will contain 8 to 10 sections. The blade 2 of the switch when pushed inwards closes the circuit connections of the section at the same time "cancelling" any previous connections made. The switch blade is bent at the right angle and a knob 3 inserted at the end pushes the blade in, while the knob may at the same time be rotated. A channel 4 is fixed to the switch body and may serve for the coil assembly as well as for the tuning mechanism. A coil 5, having a winding 6 and a threaded bushing 7 is arranged to move along its axis, when screw 8 is rotated. The rotation of coil is prevented by guide pins 9. Screw 8 is centered in the channel 4 and terminates with a pinion 10 gradually reducing in tooth height toward the knob. The knob has a hollow shaft 11 of such form as to engage with the pinion 10 when completely pressed against the pinion. When the switch is open the pinion is dis-engaged.

The movement to the right closes the switch and simultaneously or with further pressing the pinion is engaged so that the rotation of the knob produces displacement of the coil 5. The channel 4 also carries a magnetic core 13 with a thread 14 locked in position by nuts 15. The core is only moved once for initial adjustment of the core with reference to the coil. The winding 6 forms an inductance which may be connected with a fixed capacitance to form an oscillatory tunable circuit. The values of L and C are chosen to resonate the circuit at the desired frequency and the relative core movement produces the desired variation of L to cover the entire sub-range. In actual practice for the variation of L of the order of 2 a movement of 3/8'' will be required if the coil is wound as a solenoid on the thin tubing of the same internal diameter. In the case, when two circuits are simultaneously tuned the tube is extended in length so as to have adequate separation between the windings and the cores are fixed on the rod 14. The pinion 10 engages a small rack 15 with a pointer 16 indicating on a portion of a suitable dial the position to which the circuit is tuned. The dial may have printed on it call letters of the stations.

Figure 2 shows a modification of the tuning unit in which capacitors 16 and 17 consisting of two concentric cylinders is moved by a similar arrangement. The spring clutch 18 engaging cone 19 is used to engage the knob with tuning element. The coil 5 in this case is a self-supporting universal winding.

It is understood that the other tuning devices such as for instance short circuiting metal rings may be used instead of or with either magnet cores or condensers, as long as the general idea and arrangement of parts is carried out in the similar manner.

Figures 3 and 4 show the general tuner arrangements typical for the radio broadcast receiver application. Figure 3 shows the whole unit assembled around an eight section switch in which 5 positions are used for the broadcast range, subdivided into three ranges of which two ranges have duplicate tuning to enable to "preset" two stations in one sub-range and three short-wave ranges, which, for example, may be selected as follows: first 6–7 mc.; second 9.5–12 mc. and the third 15–18 mc., which subdivision practically takes care of all the world distribution of short wave stations.

One single graduated dial 22 calibrated in frequencies may be employed in the middle of the assembly, over which a transparent celluloid dial with call letters of those stations which may be conveniently heard in the given location may be superimposed to allow the operator a quick selection of five of those stations by the five upper knobs. When either of them is pushed in and once rotated to a desired station, it is left in the position for daily use. The whole assembly when mounted on a plate with associated coils, condensers, etc. comprise the whole tuning unit which for convenience may be moved within a reasonable distance from the chassis of the receiver, as it has a minimum number of outgoing connections. Additional knobs actuating volume and tone controls may also be assembled on this control panel. For the convenience of the operator to be able to quickly select desired stations in each sub-range, the knobs of each sub-range, as well as the graduations, call letters, and pointers may be marked in different colors.

Figure 1 shows that the pointers 16 are actuated by racks 15 engaged with pinions 10. Once such selections are made the call letter dial plainly indicates what stations are at the immediate disposal of the operator and to get any of these stations, he has only to press the corresponding knob.

It may also be convenient to dispose the station selector on two separate switches, having the dial 22 between the switches, in which case two 4-section switches may be used as shown in Figure 4. A large dial is employed, each horizontal line representing the calibrations of a part-range of which these upper ones may be broadcast ranges. In such an arrangement less confusion will arise as each knob is in line with its tuning range. The pointers may be actuated either by rack and pinion as previously described or by the usual system of pulleys and strings. It may be arranged in the known manner to illuminate only those parts of the dial which correspond to the position of the operating knob.

It will be noted that the short wave portion of the dial is marked somewhat different from the previously described example. There, narrow ranges are employed: first 9.4 to 9.9 mc.; second 11.5 to 12 mc. and third 14.5 to 15.5 mc. which cover most of usual stations, allowing better band spread and having certain electrical advantages, as will be later explained.

It is evident that in receivers covering a "long wave" band such as is used in European broadcasting, one or two extra sections should be added to complete the receiver.

The invention lends itself to the receiving circuits of the straight R. F. type or to superheterodyne receivers.

Figure 5 shows the electrical circuit of a two stage T. R. F. receiver embodying the invention and having 5 station selectors for broadcast range as above described. The circuit shows a high impedance choke 22 in the antenna circuit, coupled to the first circuit through a coupling condenser 23, first resonant circuit capacity 24, which may be of the order of 100 $\mu\mu$f, and ad-

justable inductors **25**, **26**, and **27**, whose approximate minimum values are respectively 400, 200 and 100 μh, with the maximum values of 880, 440 and 220 μh. Such small range of variations enables one to use highly efficient small coils for better selectivity. Tube **29** is a radio frequency amplifier in the plate of which are connected tunable circuits of another set, similar to the first set and the pre-tuning of both circuits is done simultaneously and synchronously as already described. Tube **30** is the usual detector in the plate of which conventional audio circuits are represented by telephone **31**.

Figure 6 shows the application of the invention to the oscillator circuit of a superheterodyne receiver. An oscillator tube **32** is connected for convenience as a Colpitts oscillator wherein capacitors **33** may be of 200 $\mu\mu$f each and the coils **25**, **26**, and **27** have minimum values approximately 150, 95, and 60 μh. Since a standard intermediate frequency of 455 kc. is employed the inductance variations required for tuning are reduced so that corresponding maximum values become approximately 250, 160, and 100 μh. It will be noted that since the low loss quality of the coil is relatively unimportant in the oscillator circuit very small coils not over ½'' maximum dimension may be employed for tuning. Cores made of magnetite mesh 70–140 may be employed for the broadcast range, while in the short wave region much finer magnetite dust, e. g. mesh 300 may be employed. The same considerations are applicable to short wave tuning except that the coils and condensers are of much smaller values, the coil being of the order of 1μh. at the minimum.

While it is possible to use in the superheterodyne a preselector (antenna input circuit and R. F. stage, if employed) in accordance with the showings of the Figure 5, it is sometimes preferable to simplify the circuits and to reduce their cost by the employment of a preselector constructed in accordance with Figure 7.

When the part-ranges are subdivided, substantially as previously described, it may become advantageous to tune the pre-selector to the wide band of frequencies of each part-range. With the above intermediate frequency part-ranges should be preferably smaller in frequency width, then the intermediate frequency to avoid station interference due to the 2nd harmonic. In this case as Figure 7 schematically represents, an input circuit of the band pass type is employed, having an antenna coupled inductively through a primary coil **34** to the coil **35** in parallel with which is a circuit capacitor **36** which may be of the order of 70 $\mu\mu$f for broadcast range. Coil **35** has three taps dividing the coil into three sections so that the total inductance of the coil varies in the above example from 200 to 600 μh. The first circuit is tightly coupled, with the coupling coefficient of the order of 40%, by capacity **37** and mutual inductance between two coils, to another similar circuit **35**, **36**. Three switch points **28** correspond to three part-ranges. The output of the band pass filter is fed to a grid of the mixer tube or to an oscillator-converter tube. The arrangement of the coils of the filter is shown in Figure 7 where two windings **35** are so wound that the increase of inductance brings the necessary increase of mutual inductance. It is to be noted also that the antenna coil **34** is so placed as to produce increase of coupling with increase of inductance of coils **35**. This arrangement of the preselector affords an increase of image ratio (ratio of direct signal to the second channel interference) as compared with single coil tunable input, but the cross-modulation from a neighboring strong station is somewhat increased, so that in special cases it may be advisable to employ an additional rejector circuit, tuned to the offending local station, in order to reduce its signal strength, such as shown on the figure, where **38** and **39** are respectively inductance and capacitance of the rejector circuit. A similar arrangement, but of different electrical quantities, may be employed for the reception of relatively broad short wave part-ranges, such as were set as one example of Figure 3. In that case, where narrow part-ranges are employed, such as in Figure 4 the preselector circuit will consist of a single circuit, tuned for the middle of each narrow band, the arrangement being substantially as was shown in one part of the band pass filter, by using tapped coils of appropriate value, the free ends of the coil may be adjustable by magnetic type trimmers.

Should it be required to employ an additional R. F. tube for better sensitivity on the short wave, a second tapped coil may be employed, substantially as in the T. R. F. circuit of Figure 5, also tuned to a middle of each part-range, but it may be preferable to slightly stagger the resonance points of two coils in order to avoid attenuation towards the ends of the part range.

What I claim is:

1. A radio tuning device for instantaneous selection and presetting of the desired stations including a plurality of adjustable circuits each tunable over a limited sub-range of a normal frequency spectrum, the circuit constants being so chosen as to cover said spectrum in steps, tuning means to vary the inductance of the circuits, electrical switching means to bring into operation the circuits corresponding to the desired range, a common operating member for said switching and said tuning means, said member being normally disconnected from the tuning means, and means responsive to a switching operation of said member to interconnect the latter to said tuning means.

2. A radio tuning device according to claim 1 in which a common dial having plurality of sub-ranges for each set of circuits are employed, each circuit being provided with its own indicator within a sub-range.

3. In a superheterodyne receiver, having an input pre-selector circuit, an oscillator and an intermediate frequency channel a tuning device for an instantaneous selection and pre-setting of the desired station including a plurality of adjustable oscillator circuits, each independently and continuously tunable over a limited sub-range of the normal frequency spectrum tuning means to vary the inductance of said oscillator circuits, electrical switching means to bring into operation the circuits corresponding to the desired sub-range, a common operating member for said tuning and said switching means, and means responsive to a switching operation of said member to interconnect the latter to said tuning means.

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