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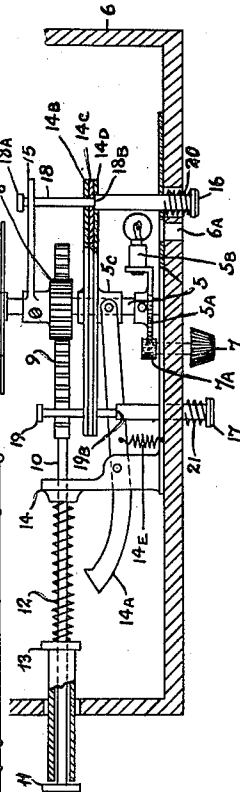
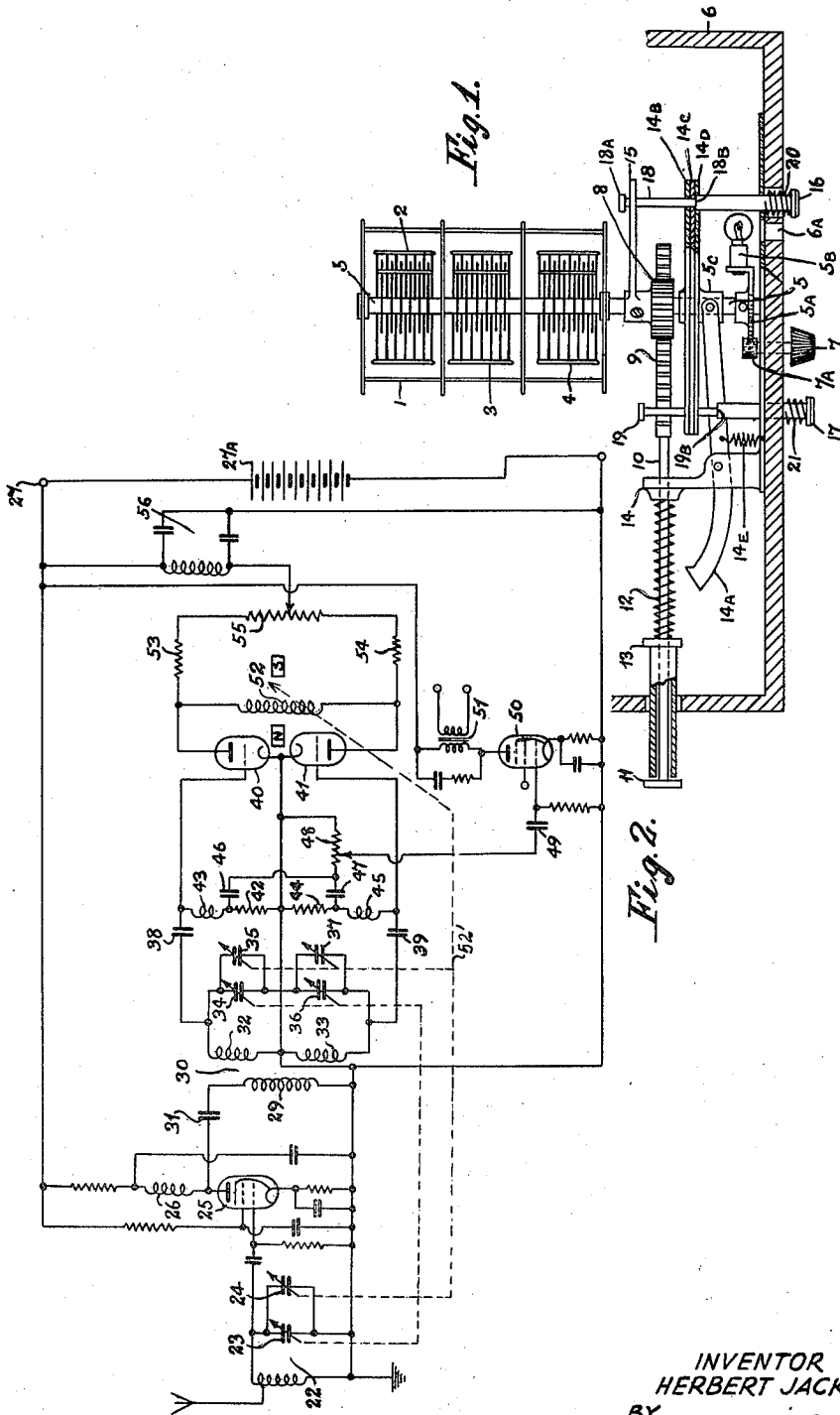
H. JACKSON

2,231,386

AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

Filed Feb. 23, 1935

2 Sheets-Sheet 1



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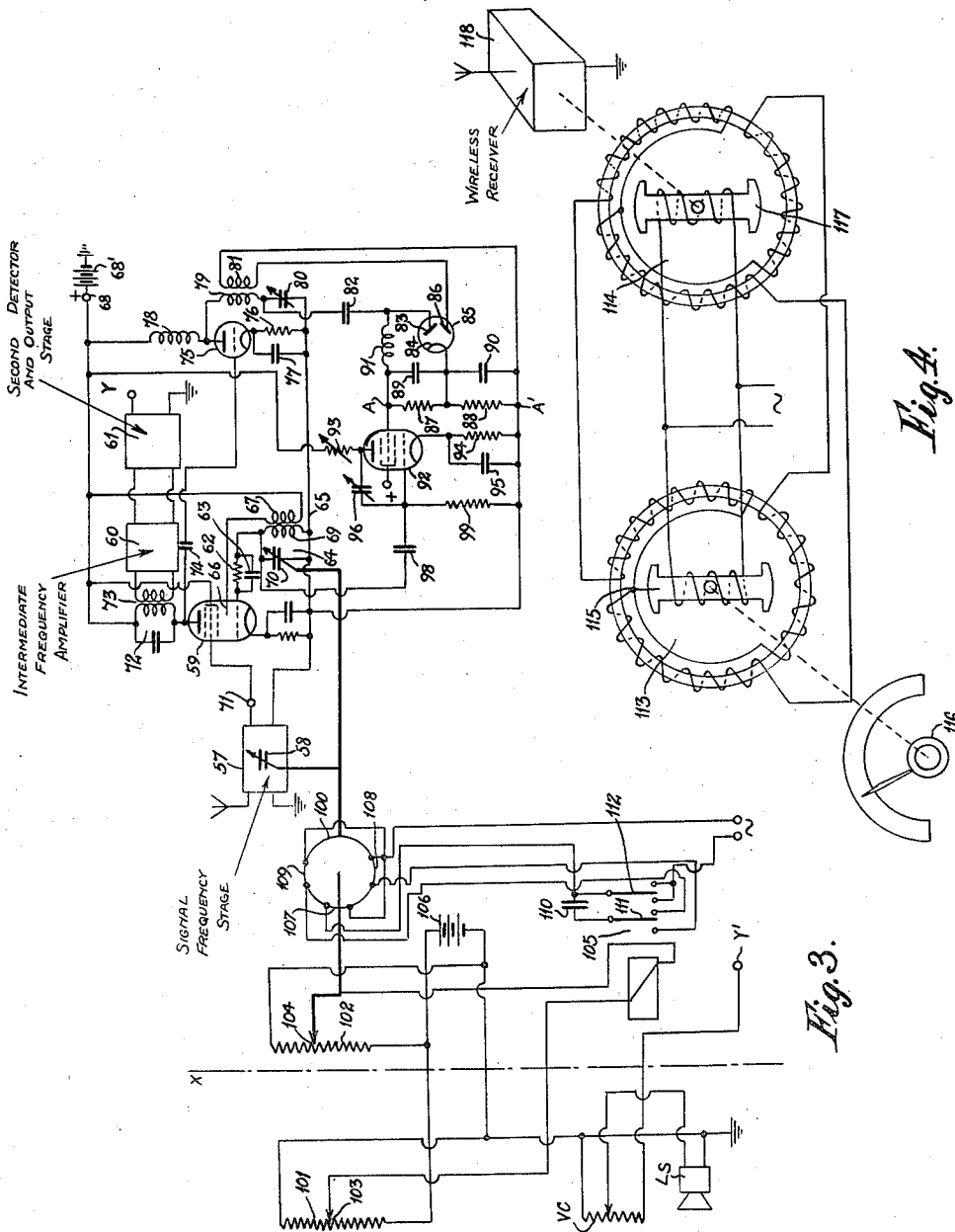
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AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

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2 Sheets-Sheet 2



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2,231,386

AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

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Application February 23, 1935, Serial No. 7,778
In Great Britain February 24, 1934

6 Claims. (Cl. 250—20)

The present invention relates to automatic tuning devices for radio receivers. The invention is concerned with tuning control apparatus which operates indirectly to adjust the setting of a tuning member of the receiver. An adjustment may be regarded as indirect for the purposes of this specification when it is effected otherwise than by the agency of a direct rigid, frictional or like mechanical coupling between the adjusting means and the tuning member.

On account of the large numbers of broadcasting stations having wavelengths within the restricted compass of the broadcast wavebands, the selectivity of broadcast receivers of good sensitivity must be made high, so that a desired signal may be received without adjacent channel interference. It is found, however, that the operation of tuning a highly selective receiver is one requiring considerable accuracy, since mistuning may result in serious distortion; when such a receiver is not accurately tuned, adjacent channel interference and sideband cutting, among other influences, may mar the reception of the desired signal.

The need for highly critical tuning is an important factor in the design of indirect tuning control apparatus; in a case, for example, in which tuning is effected by the adjustment of a variable condenser, it may be necessary to adjust the condenser to within a fraction of a degree of arc of the correct setting in order to avoid distortion, and indirect control apparatus capable of such an accuracy is complicated, difficult to set up, and expensive to manufacture.

It is the principal object of the present invention to provide wireless or like apparatus, comprising a receiver and indirect tuning control means therefor, in which a desired accuracy of tuning may be simply achieved, although the indirect control means, of itself, may be incapable of effecting such accurate tuning.

According to the present invention, wireless or like apparatus comprises a signal receiver having an adjustable tuning member, and tuning control means adapted to operate indirectly for effecting adjustment of said member, said apparatus comprising, at the receiver, fine-tuning means adapted to operate automatically to compensate for lack of precision in the operation of said tuning control means.

The tuning control means referred to in the preceding paragraph may be arranged at the receiver itself, or they may comprise a control member arranged at a remote point; they are

preferably adapted to tune the receiver to any of a number of pre-selected tuning positions. The fine-tuning means operate to provide what will be referred to as "pull-in" tuning, that is to say, when the receiver has been approximately tuned to a desired signal, the fine-tuning means operate to pull the receiver exactly into tune with that signal.

Various embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which

Fig. 1 is a diagrammatic drawing of a form of push-bottom tuning control device which may form a part of apparatus according to this invention,

Fig. 2 is a circuit diagram of a wireless receiver incorporating means for providing pull-in tuning, and suitable for use in association with the tuning control device of Fig. 1,

Fig. 3 is a circuit diagram of a preferred form of apparatus according to the invention, incorporating a superheterodyne receiver having pull-in tuning, and means for controlling the tuning of the receiver from a remote point, and

Fig. 4 illustrates a further form of apparatus according to the invention.

Referring to Fig. 1, the tuning condenser 1 of a wireless receiver comprises three condenser sections 2, 3 and 4 having their rotor elements mounted upon a common control spindle 5. The spindle 5 carries a pinion 5A which co-operates with a pinion 1A, the latter being coupled to a knob 7 which is mounted on the cabinet 6 of the receiver and provides manual tuning.

Keyed to the spindle 5 is a pinion 8 which co-operates with a rack 9; the latter bears a rod 10 which projects through the side of the cabinet 6 and terminates in a push-key 11. A helical spring 12 is connected between a boss 14 on the cabinet wall and a boss 13 secured to the rod 10, the action of this spring being to tend to push the rack 9 to the left, and to turn the rotor vanes of condenser 1 into the maximum capacity position. When the key 11 is urged to the right to its full extent, against the action of spring 12, a catch 14A, which will be referred to as the reset catch, engages the boss 13 and holds key 11 in this position; in these circumstances, the condenser 1 is at its minimum capacity setting.

The spindle 5 also bears a radial arm 15 which is arranged to co-operate with a plurality of station selector keys, of which only two, numbered 16 and 17, are shown for simplicity. The station

keys bear stops numbered 18 and 19 respectively, which project through the cabinet wall and are normally held out of the path of the arm 15 by suitable springs 20 and 21 respectively.

The station keys and their associated stops are so constructed and arranged that when any one of the keys is depressed, and the arm 15 is rotated until it abuts against the stop associated with that key, the setting of the condenser 1 corresponds to the tuning position of the station represented by the key in question. A separate selector key is provided for each of any number of stations which it may be desired to pre-select.

The operation of the arrangement is as follows. Assume firstly that the condenser 1 is held in the minimum capacity setting by the re-set catch 14A, and that the station key 16 is depressed to bring its associated stop 18 into the path of the arm 15, as shown: as the key 16 is depressed a shoulder 18B formed on stop 18 comes into contact with plate 14BCD and urges it forward, the plate 14BCD being secured to a sliding boss 5C on spindle 5. Plate 14BCD is coupled to the re-set catch 14A, and a spring 14E is provided to hold catch 14A normally in engagement with boss 13. When key 16 is fully depressed, catch 14A is released; the spindle 5 commences to turn under the thrust of the spring 12, and the arm 15 is carried around with the spindle until it is brought to rest by stop 18 of key 16. The enlarged end 18A of stop 18 prevents the latter from disengaging from the arm 15. If the positioning of the stop 18 has been sufficiently accurately predetermined, the receiver is now tuned to the station represented by key 16.

If now it is desired to receive the station represented by key 17, for example, the re-set key 11 is first depressed to its full extent; this operation causes the stop 18 of key 16 to be released, and the re-set catch re-engages boss 13. Station key 17 is now depressed, and a similar cycle of operations takes place.

The arrangement described is difficult to adjust for accurate tuning, and if the station key stops or the arm 15 wear or become deformed, the original accuracy is lost. As is more fully explained hereinafter, pull-in tuning is accordingly provided to compensate for lack of precision on the part of the tuning control.

The tuning control device described is an example of a simple indirect tuning device, and many modifications and elaborations of the arrangement described will occur to those versed in the art; for example, the station keys may be arranged on the receiver cabinet 6 in any desired way, provided that the station-key stops are so shaped and disposed as to arrest the spindle arm 15 in the desired positions. The keys may conveniently be disposed on the circumference of a semicircle having the spindle 5 as centre. The re-set key may be dispensed with, and the control knob 7 employed for restoring the condenser 1 to the minimum capacity setting; it may be arranged that when catch 14A is latched behind boss 13, the knob 7 may be freely rotated, to allow the receiver to be readily tuned by hand.

A suitable indicating lamp 5B is coupled to spindle 5 for rotation therewith, and each station key is disposed near to a hole in the cabinet (one such hole, 6A, being shown), the arrangement being such that when the receiver is tuned to the station represented by key 17, for example, the lamp 5B is disposed behind the hole, 6A, associated with that key.

The plate 14BCD is in three parts; a plate 14B is rigidly secured to the sliding boss 5C, and carries a plate 14C of insulating material, on the face of which is arranged a metal plate 14D, the whole structure forming part of a switch for wave-range changing purposes. The arrangement is as follows: Assuming that station key 17 corresponds to a long wave station, while key 16 corresponds to a station on a shorter wave band, when key 17 is depressed, it is arranged that the shoulder 18B engages metal plate 14D; when key 16 is depressed, however, it is arranged that shoulder 18B passes through an opening in plate 14D and engages insulation plate 14C. This contact may be arranged to short-circuit an inductance coil 15 for wave-range changing, either directly or through the agency of a relay.

Now it is known that, in order to obtain reception free from interference and distortion, it may be necessary to tune the receiver to a desired station with an error of not more than a fraction of a degree of arc. The tuning device described is only capable of this degree of accuracy if very great care is exercised in setting it up, and even so, is not capable of taking account of small changes in the wavelengths of the stations to which selector keys are allotted. Furthermore, if in the course of time the spindle arm or the station-key stops become deformed or worn, the original accuracy of tuning is lost.

Accordingly, the receiver is provided with means for effecting pull-in tuning to compensate for deficiencies on the part of the tuning control device. Fig. 2 shows a wireless receiver of the so-called straight type, incorporating pull-in tuning means. It will be assumed that the receiver shown in Fig. 2 incorporates the tuning control device described with reference to Fig. 1.

Referring to Fig. 2, a wireless receiver comprises an input tunable circuit 22 having a variable tuning condenser 23 shunted by a vernier, or fine-tuning condenser 24. Oscillations from the circuit 22 are fed to a high-frequency pentode amplifying valve 25 having its anode connected through a high-frequency choke coil 26 to the positive terminal 27 of a source of anode current illustrated generically by battery 27A; the negative terminal of the source, which may comprise a suitable rectifier instead of the battery illustrated, is connected to the grounded side of the receiver circuit.

The valve 25 feeds the primary winding 29 of a high-frequency transformer 30 through a coupling condenser 31. The secondary winding of transformer 30 is in two halves comprising coils 32 and 33; the mid-point of the secondary winding is earthed.

Coil 32 is shunted by a tuning condenser 34 which, in turn, is shunted by the vernier condenser 35, and coil 33 is shunted by tuning condenser 36 and vernier condenser 37. Oscillations set up across the two halves of the secondary winding of transformer 30 are fed through coupling condensers 38 and 39 to the control grids of two valves 40 and 41, which have their cathodes connected together and to earth.

Received signal oscillations undergo full wave diode rectification in the grid circuits of the valves 40 and 41. The grid circuit of valve 40 includes a leak resistance 42 in shunt with a high-frequency choke 43, and the grid circuit of valve 41 comprises leak resistance 44 and choke 45. The modulation frequency oscillations set up across resistances 42 and 44 are fed through con-

condensers 46 and 47 to a volume control potential divider resistance 48 connected as shown.

A variable tapping point in resistance 48 is connected through a coupling condenser 49 to the control grid of an output pentode valve 50; the latter valve serves to amplify the modulation frequency oscillations and has in its anode circuit the primary winding of an output transformer 51 adapted to feed a loudspeaker, not shown.

The condensers 23, 34 and 36 are ganged to a common spindle for simultaneous actuation, and may be considered as corresponding to condensers 2, 3 and 4 of Fig. 1; vernier condensers 24, 35 and 37 are also ganged to a common shaft. Means of any suitable kind such as the arrangement already described in connection with Fig. 1, are provided for achieving wave-band switching, and decoupling condensers and resistances are provided in known manner throughout the circuit. More than one high-frequency amplifying stage may be provided if desired.

Connected between the anodes of the valves 40 and 41 is a coil 52, which is mounted in a magnetic field in such a manner as to be capable of rotating freely therein, and is arranged to control the settings of vernier condensers 24, 35 and 37 as shown by the dotted line 52' in Fig. 2. The ends of this coil are connected through load resistances 53 and 54 to the ends of a potential divider resistance 55, a variable tapping point in which is connected through a high-frequency filter 56 to the terminal 27 of the anode current source.

It is arranged that at any setting of the condensers 23, 34, 36 the circuit 32, 34 is tuned to a frequency slightly above the frequency to which circuit 22 is tuned, while circuit 33, 36 is tuned to the same extent below the frequency of circuit 22. If now the circuit 22 is accurately tuned to a signal, the signal potential difference set up across circuit 32, 34 is the same as that set up across circuit 33, 36, and, assuming the characteristics of valves 40 and 41 to be matched, the anode currents in these valves are the same. In these circumstances, that is to say, when circuit 22 is accurately tuned, it is arranged that no current flows in the coil 52; this is achieved by adjusting the tapping point in resistance 55 until the bridge constituted by elements 52, 53, 54 and 55 is balanced.

The coil 52 is mechanically coupled to the common shaft to which vernier condensers 24, 35 and 37 are ganged, and it is arranged that when the anode current of valve 40 exceeds that of valve 41, the capacities of the vernier condensers are increased, while when the anode current of valve 40 is less than that of valve 41, the vernier condenser capacities are decreased.

Suppose now that a certain station key is incorrectly positioned so that, when depressed, it stops the main tuning condenser 23 at a position such that its capacity is slightly lower than the correct setting; then the circuit 33, 36 is more accurately tuned to the desired station than is circuit 32, 34 and more anode current flows in valve 40 than in valve 41.

A potential difference is thus set up across coil 52, and current flows in this coil in such sense that the capacity of the vernier condensers is increased. This has the effect of reducing the frequency to which circuit 22 is tuned, thus tending to correct for the initial tuning error; furthermore, the frequencies to which circuits 32, 34 and 33, 36 are tuned are decreased, and when the correct tuning condition is attained, these circuits are equally

mistuned, the potential difference across coil 52 falls to zero, and no further adjustment of the vernier condensers takes place. Thus the receiver automatically takes up the correct tuning setting, that is, pull-in tuning is obtained; furthermore, correct tuning is maintained if the station frequency alters slightly.

Pull-in tuning is achieved in a similar manner when a station key which tunes the receiver to a frequency lower than the station frequency is operated. In this case, circuit 32, 34 is more accurately tuned than circuit 33, 36, and current flows in coil 52 in such a sense as to tend to reduce the vernier condenser capacities.

Many modifications of the pull-in tuning arrangements described are possible, and will readily occur to those versed in the art. For example, the modulation frequency output may be taken from the anode circuits of the valves 40 and 41 instead of from the grid circuits, and in order to ensure correct matching and equivalent deterioration, the valves 40 and 41 may be replaced by a double triode valve having a common cathode. If desired, a separate detector may be employed, the valves 40 and 41 being employed solely for operating the vernier condensers. The output of valves 40 and 41 may be amplified in direct coupled amplifiers so as to ensure that an adequate force is produced by coil 52 to rotate the vernier condensers. The coil 52 may be replaced by a single centre-tapped coil, or by two coils oppositely wound. If the main tuning condenser spindle is sufficiently light and freely rotating, and if the tuning control means are of a suitable kind, the vernier condensers may be omitted, and the condenser spindle may then be driven by the coil 52 itself; alternatively, a reversible electric motor may be provided to rotate the condenser spindle.

The present invention may also be applied to receivers having tuning means operable from a remote point; since pull-in tuning is provided, the remote control means need not be arranged to provide a very high degree of accuracy, and many simple remote control devices may therefore be employed. Fig. 3 shows a preferred form of wireless apparatus according to the present invention, which incorporates remote tuning control means.

Referring to Fig. 3, a superheterodyne receiver comprises a high-frequency amplifying stage 57, comprising a variable condenser 58, a heptode valve 59 which acts as local oscillator and mixer, an intermediate-frequency amplifier 60, and a second detector and output stage 61. The first control grid, that is, the inner grid of the heptode valve 59, is connected through a leak resistance 62 shunted by a grid condenser 63, and through a parallel resonant circuit 64, to the chassis, which is indicated by the line 65. An electrode 66, which serves as an anode for the generation of local oscillations, is connected through a coil 67 to a point 68 in a source of anode current indicated generically by battery 68'; the negative terminal of the source is returned to the chassis and is earthed, and other points in the figure which are marked with a positive sign are connected to points in the source at suitable positive potentials. The coil 67 is coupled to the coil 69 of resonant circuit 64 and the variable condenser 70 of that circuit is ganged to the variable condenser 58, in the signal frequency stage 57 of the receiver, so that only one tuning control is necessary.

The second control grid of the heptode is con-

connected to the output terminal 71 of the signal frequency stage 57 of the receiver.

The anode circuit of the heptode 59 comprises a parallel resonant circuit 72 tuned to the intermediate frequency; a coupling coil 73 is coupled to the tuned circuit 72, and feeds the intermediate frequency amplifier 60. A coupling condenser 74 is connected between the anode of heptode 59 and the control grid of auxiliary intermediate frequency amplifying valve 75. The cathode of this valve is connected to the chassis through a biasing resistance 76 shunted by a by-pass condenser 77, and its anode is connected through an intermediate-frequency choke coil 78 to the anode current source.

The anode of the valve 75 is connected to the chassis through a series resonant circuit comprising a coil 79 and a condenser 80; the latter is preferably made adjustable. A further coil 81 is coupled to the coil 79. The values of the circuit elements 79, 80, 81 and 82 are made such that the potential difference set up at the exact intermediate frequency across coil 81 is equal to that set up across condenser 80 at that frequency.

The junction point of condenser 80 and coil 79 is connected through a condenser 82 to the anode 83 of a double-diode valve 85 having a cathode 84, and the coil 81 is connected between the anode 86 and cathode 84 of valve 85. The diode 83, 84 has a load resistance 87 of value such as 5 megohms for example, and diode 86, 84 has a load resistance 88 of substantially the same high value. The load resistances 87 and 88 are shunted by by-pass condensers 89 and 90 respectively, which may have a capacity of 0.01 microfarad. An intermediate frequency choke coil 91 is connected in shunt with diode 83, 84 and resistance 87 to complete the external D. C. circuit of diode 83, 84.

The end A of load resistance 87 remote from the cathode 84 of valve 85 is connected to the outer control grid of a hexode valve 92, having its anode connected through a resistance 93 to the anode current source. The end A' of the resistance 88 remote from the cathode 84 of valve 85 is connected to the chassis 65, and the cathode of hexode 92 is connected through a biasing resistance 94 shunted by a by-pass condenser 95 to the chassis.

The inner control grid of hexode 92 is connected to that side of condenser 70 which is not directly connected to the chassis, through a condenser 98. A grid leak 99 is connected as shown. A condenser 96 is connected between the anode of hexode 92 and the inner grid thereof; the function of this condenser will be explained hereinafter. Condenser 96 may have a capacity of the order of 10 micro-microfarads.

The common tuning shaft of condensers 58 and 70 is rigidly coupled to the armature of a reversible electric motor 100, which is arranged to tune the receiver under the control of an operator at a remote point. In this figure, parts to the left of the dotted line X—X are assumed to be at the remote point. The terminal Y is assumed to be connected to terminal Y', so that the output of the output stage of the receiver is fed to the remote loudspeaker LS. The latter is associated with a volume control VC, and a loudspeaker (not shown) is also provided at the receiver itself.

The operation of the motor 100 is controlled from the remote point by means of a Wheatstone bridge comprising two potential divider resist-

ances 101 and 102 which have their adjustable tapping points 103 and 104 connected together through the winding of a polarised relay 105 of known kind. Across the other diagonal of the bridge is connected a source of current such as battery 106.

The motor 100 has an armature winding 107 which is fed with alternating current from a suitable source such as the mains, and two separate stator windings 108 and 109, which are energized through phasing condenser 110. The direction in which the armature moves depends upon which of windings 108 and 109 is energised, these windings being connected and arranged in such a manner that by disconnecting one of them and switching in the other, the motor is reversed.

Potential divider resistance 101 at the remote point has a movable arm for varying the position of tapping point 103, this arm being associated with a tuning scale engraved, for example, with the names of broadcasting stations; the corresponding movable arm of potential divider resistance 102 at the receiver is mechanically coupled to the armature of motor 100.

When the bridge comprising resistances 101, 102 is balanced, there is no current in the winding of relay 105, and the contact-makers 111, 112 are in the mid-positions as shown; in these circumstances, the motor 100 is deenergised. Suppose now the movable arm of resistance 101 is moved to a fresh position corresponding to a desired station. The balance of the bridge is disturbed, current flows in the winding of relay 105 and contact makers 111 and 112 move to the right or left. The armature of relay 105 is polarised, as already stated, and thus if current flows in one direction in the relay winding, motor windings 107 and 108 are energised, whilst if current flows in the other direction, motor windings 107 and 109 are energised.

The armature of motor 100 thus commences to turn, and the tuning of the receiver undergoes adjustment. Furthermore, the movable arm of resistance 102 is caused to move in such a sense as to restore the balanced condition of the bridge, and when this condition is attained, relay 105 is released, and the motor 100 is de-energised.

The remote control arrangement described can be made to provide approximately correct remote tuning, but cannot, for a number of reasons, give a high degree of accuracy; among these reasons are, firstly, that the sensitivity of the relay 105 is limited, so that the motor circuit is likely to be opened before the bridge reaches the balanced condition, and, secondly, that the motor 100 does not stop instantaneously when it is de-energised. Pull-in tuning is accordingly provided to compensate for the inadequacies of the remote control means. The way in which pull-in tuning is obtained will now be considered.

It has already been explained that the potential differences set up across coil 81 and condenser 80 at the intermediate frequency, that is, where a station is accurately tuned in, are equal. The diodes 83, 84 and 86, 84 have very high load resistances; thus the potential differences set up across the load resistances are very nearly equal to the peak voltages applied to the diodes from coil 81 and condenser 80 respectively, the losses in the diodes being negligibly small. It is therefore not essential that the two diodes should be accurately matched, since the rectified voltage in each case is substantially independent of the characteristics of the diode. Hence when a station is accurately tuned in, there is no potential

difference between points A and A', and the outer control grid-cathode bias potential of hexode 92 is determined only by the voltage drop across resistance 94.

Hexode valves have the following important property: the mutual conductance from, say, the inner grid to the anode may be varied by varying the bias on the outer control grid, and since variations in mutual conductance are accompanied by corresponding changes in amplification factor, the amplification factor with respect to the inner grid may be varied by varying the outer control grid-cathode potential difference, for example.

Now it is known that in a circuit comprising a thermionic valve having a non-reactive load, such as a resistance, connected in its anode circuit, there appears in the grid-cathode circuit of the valve a "reflected" capacity dependent upon the magnitude of the anode to grid capacity and upon the voltage amplification of the valve. In the arrangement shown in Fig. 3, the hexode 92 has a non-reactive load comprising resistance 93, and its inner grid-cathode circuit is connected in parallel with the oscillator tuning condenser 70. The reflected capacity referred to above is effectively in shunt across the tuning condenser 70, and the tuning of the receiver is thus dependent upon the magnitude of the reflected capacity.

The latter may be varied by varying the voltage amplification of the hexode, and this in turn may be made to depend upon the inner grid-cathode potential difference. It will now be shown that this potential difference is dependent upon the extent to which the receiver is off-tune with respect to a desired signal, so that the tuning of the receiver is made to adjust itself automatically to compensate for a certain degree of mistuning; that is to say, pull-in tuning is effected.

It will be clear that if the receiver is tuned only approximately to a station, so that, for example, the actual frequency to which the receiver is tuned is slightly lower than the signal frequency, the resulting intermediate frequency will be, say, less than the value corresponding to a condition of precise tuning, assuming that the local oscillation frequency is always higher than the signal frequency. In these circumstances, the potential difference set up across condenser 80 is larger than that set up across coil 81, and more current flows in diode 83, 84 than flows in diode 86, 84; point A thus becomes more negative than point A', and the outer control grid bias of hexode 92 is increased in the negative sense.

On account of this increase in negative bias, the amplification factor of the hexode is decreased, and the reflected capacity is also decreased. Since the reflected capacity is in shunt with the tuning condenser 70 of the local oscillator circuit 64, the frequency of the local oscillation is thus increased, the intermediate frequency is correspondingly increased, and the potential difference between points A and A' is reduced. The effect continues until the potential difference between points A and A' becomes zero, in which circumstances the intermediate frequency has its correct value, and the receiver may be regarded as being in tune, although in fact the signal frequency circuits remain slightly mistuned.

If on the other hand the receiver is mistuned to a frequency slightly above the signal frequency, the potential difference set up across coil 81 is greater than that set up across condenser 80, and the potential of point A thus becomes more positive than that of point A'. The magnification factor of hexode 92, and hence the reflected

capacity, is thus increased, and the local oscillation frequency is therefore decreased.

It will be noted that the change in oscillator tuning capacity corresponding to a certain degree of mistuning is a larger fraction of the oscillator capacity when the receiver is tuned to a station at the short wave end of the medium wave broadcast band, for example, than when the receiver is tuned to a station of longer wavelength, since in the former case the oscillator tuning capacity is much less than in the latter case.

The efficiency with which pull-in tuning operates in this arrangement is therefore greater when receiving stations of short wavelength than when receiving long wave stations, and means are accordingly provided for obviating or reducing this variation in efficiency.

It has been pointed out that the anode of hexode 92 is connected to its inner grid by condenser 96, which serves to supplement the natural capacity between these electrodes, so that an adequate reflected capacity may be obtained. The condenser 96 is preferably made variable, and is preferably ganged to the tuning control of the receiver in such a manner that it has a greater value when the receiver is tuned to a long wave station than when the receiver is tuned to a short wave station. In this way, it can be arranged that the reflected capacity for a given degree of mistuning is a substantially constant fraction of the oscillator tuning capacity, so that pull-in tuning of substantially constant efficiency is obtained.

Another way of achieving the same result is to arrange that the resistance 93 has a larger value when the receiver is tuned to a long wavelength than when it is tuned to a short wavelength. Resistance 93 may accordingly be made adjustable, or may be replaced by a plurality of resistances and a suitable switch for connecting one or another of these resistances in circuit. The adjusting or selecting means respectively are preferably ganged to the tuning control.

A combination of the two methods may be employed if desired; in this case, either condenser 92 or resistance 93 may be made continuously variable and ganged to the tuning control, the remaining element, that is, the resistance or condenser respectively, being arranged to have a suitable different value for each of the wave-ranges to be covered; the change from one value to the other may be effected by means of the wave-range changing switch of the receiver.

It will be appreciated that the application of pull-in tuning to a superheterodyne receiver is less complicated than its application to so-called straight receivers, since in the case of the superheterodyne, it is only necessary to control the tuning of one tuned circuit, that is to say, the circuit controlling the frequency of the local oscillation; furthermore, the discriminating circuit, which determines the sense in which compensation for mistuning is applied (and in the case of the receiver described in Fig. 3 is the circuit comprising condenser 80 and coil 81) may be fixedly tuned to the intermediate frequency of the receiver. If desired, however, the receiver described in Fig. 3 may be modified by arranging that compensation for mistuning is also applied to the signal frequency circuits.

From the point of view of its function in assisting pull-in-tuning, the hexode 92 may be regarded as simulating a variable capacity, since it is the variation in the reflected capacity which is employed to control the local oscillator frequency. However, instead of a valve arranged,

in a manner such as that described, to simulate a variable capacity, a valve arranged to simulate a variable impedance of any other suitable kind may be employed. For example, a valve arranged so that its anode-cathode impedance may be varied to control the effective inductance, and hence the tuning of a resonant circuit may be employed.

Furthermore, other remote control systems than the Wheatstone bridge system described may be employed; one such system which is illustrated in Fig. 4 comprises two electric motors, of which one, numbered 113, is arranged at the remote point, while the other 114, is arranged at the receiving point, the motors being so constructed and connected together that movement of the rotor 115 of motor 113, in response to motion of a tuning knob 116, produces a corresponding movement of the rotor 117 of the motor 114. The rotor 117 is coupled to a tuning member of a receiver 118, and approximate tuning of the receiver is thus obtained from the remote point. The receiver 118 may be of the kind shown in Fig. 2 or 3 for example. In this system, the torque to which the rotor 117 is subjected varies as the square of the phase difference between the two rotors, and hence the torque for small phase differences is extremely small. Remote control is very difficult to achieve with such a system unless pull-in tuning is employed according to the present invention.

If desired, means may be provided for disconnecting the remote control device to enable the receiver to be tuned directly, that is, by the direct manual rotation of the tuning condenser spindle. Means may also be provided for disconnecting the loudspeaker from the receiver during the operation of tuning.

Other modifications of the arrangements described, within the scope of the appended claims, will readily occur to those versed in the art.

I claim:

1. Apparatus for receiving modulated carrier oscillations, comprising an adjustable resonant circuit, a tuning member for adjusting said circuit over a wide frequency range, tuning control means associated indirectly with said tuning member for adjusting said member to different frequencies of said range and tuning said circuit approximately at each adjustment for the reception of a desired carrier, fine-tuning means, means for automatically operating said latter means when there is a discrepancy of less than a predetermined amount between the frequency to which said circuit is tuned by said control means and the frequency to which said circuit should be tuned for the reception of said desired carrier, and means for deriving radio-frequency oscillations from said desired carrier and for feeding said oscillations to said automatically operating means for causing said fine tuning means to reduce said discrepancy said deriving means comprising a pair of tubes having a common input circuit and a common output circuit, said automatic operating means being connected to the said common output circuit, said common input circuit being arranged to rectify said oscillations, and means for deriving modulation voltage from the rectified oscillations in said common input circuit.

2. Apparatus for receiving modulated carrier oscillations, comprising an adjustable resonant circuit, a tuning member for adjusting said circuit, biasing means for biasing said tuning member into one extreme setting, re-setting means

for urging said tuning member into the other extreme setting, a plurality of separately operable selecting devices for holding said tuning member against the action of said biasing means at any of a plurality of pre-determined settings intermediate said extreme settings, thereby tuning said circuit approximately for the reception of a desired carrier, a source of light adjustable in position with said tuning member thereby to produce independent visible indications at said plurality of settings, fine-tuning means adapted to be operated automatically when there is a discrepancy of less than a pre-determined amount between the frequency to which said circuit is tuned when said tuning member is held at one of said intermediate settings and the frequency to which said circuit should be tuned for the reception of said desired carrier, and means adapted to be fed with radio-frequency oscillations derived from said desired carrier for operating said fine-tuning means when fed by said oscillations, thereby automatically reducing said discrepancy.

3. Apparatus for receiving modulated carrier oscillations, comprising an adjustable resonant circuit, a tuning member for adjusting said circuit over a wide frequency range, a fine-tuning device associated with said circuit, tuning control means associated indirectly with said member for adjusting said member to different frequencies of said range and tuning said circuit approximately at each adjustment for the reception of a desired carrier, fine-tuning means adapted to be operated automatically when there is a discrepancy of less than a pre-determined amount between the frequency to which said circuit is tuned by said control means and the frequency to which said circuit should be tuned for the reception of said desired carrier, and rectifier means adapted to be fed with radio-frequency oscillations derived from said desired carrier for causing said fine-tuning means to operate when fed by said oscillations, thereby automatically adjusting said fine-tuning device to reduce said discrepancy said rectifier means comprising a pair of electron discharge tubes having a common input circuit constructed and arranged for full wave rectification, means for deriving modulation voltage from the input circuit, a common output circuit for said pair of tubes, and said fine-tuning means being connected to said output circuit.

4. In combination with a radio receiver of the type having a main tuning device constructed to tune the receiver to different carrier frequencies of a relatively wide frequency range, a station selector mechanism for automatically adjusting said tuning device and including a plurality of push button members for predetermining the adjustment of the tuning device to said different frequencies, a tuning device supplemental to said main tuning device for accurately tuning said receiver at the predetermined adjustments of the main tuning device, means, responsive to received carrier energy as the main tuning device approaches each predetermined adjustment, for actuating said supplemental tuning device to perform accurate tuning and a light source mechanically associated with said main tuning device for simultaneous adjustment therewith with respect to said plurality of push button members whereby a plurality of independent, visible indications appear at settings of said tuning device corresponding to said members.

5. In combination with a radio receiver of the type having a main tuning device constructed to tune the receiver to different carrier frequencies of a relatively wide frequency range, a station selector mechanism for automatically adjusting said tuning device and including a plurality of push button members for predetermining the adjustment of the tuning device to said different frequencies, a tuning device supplemental to said main tuning device for accurately tuning said receiver at the predetermined adjustments of the main tuning device, and means, responsive to received carrier energy as the main tuning device approaches each predetermined adjustment, for actuating said supplemental tuning device to perform accurate tuning, said responsive means comprising a pair of electron discharge devices having a common rectification input circuit and a common output circuit, means connected to said input circuit to derive audio voltage therefrom, means in said output circuit for deriving a unidirectional voltage from said carrier energy, and said supplemental tuning device including a member connected to said common output circuit and responsive to said voltage.

6. In combination with a radio receiver of the

type having a main tuning device constructed to tune the receiver to different carrier frequencies of a relatively wide frequency range, a station selector mechanism for automatically adjusting said tuning device and including a plurality of push button members for predetermining the adjustment of the tuning device to said different frequencies, a tuning device supplemental to said main tuning device for accurately tuning said receiver at the predetermined adjustments of the main tuning device, and means, responsive to received carrier energy as the main tuning device approaches each predetermined adjustment, for actuating said supplemental tuning device to perform accurate tuning, said main tuning device comprising a gang of variable condensers, said supplemental tuning device including an adjustable reactance electrically associated with at least one condenser of said gang and an electrical lamp mechanically associated with the rotor element of said gang whereby the position of the lamp is varied with adjustment of the rotor element with respect to said push button members.

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