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H. L. DIETRICH

RECEIVER

Filed Jan. 17, 1940

Serial No.
314,195

2 Sheets-Sheet 1

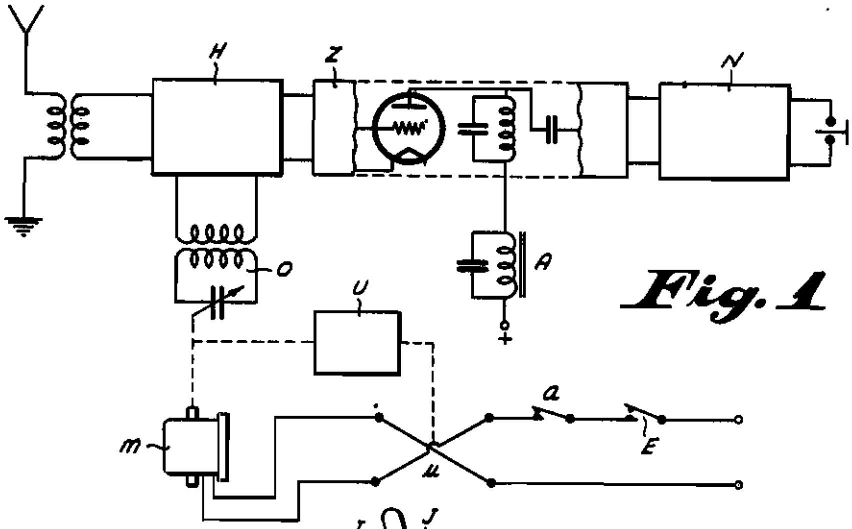

Fig. 1

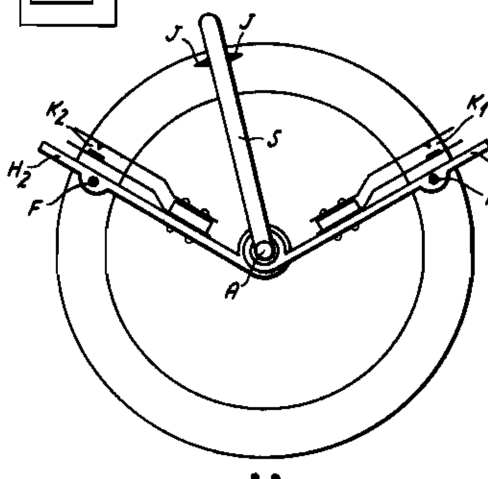

Fig. 2

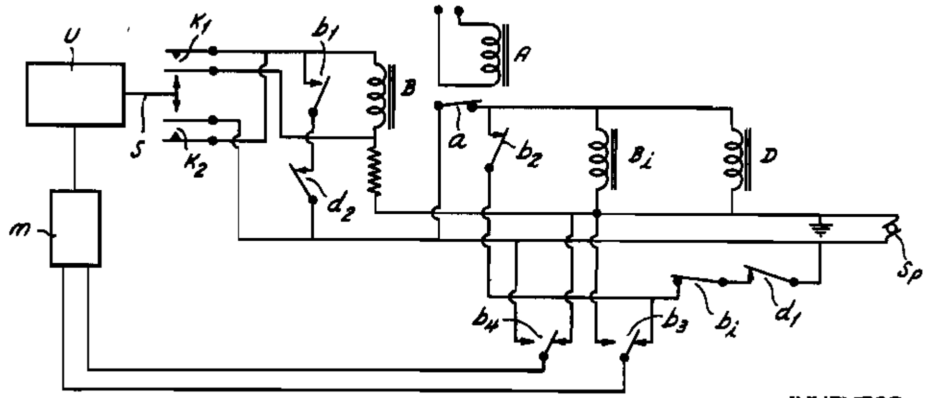

Fig. 3

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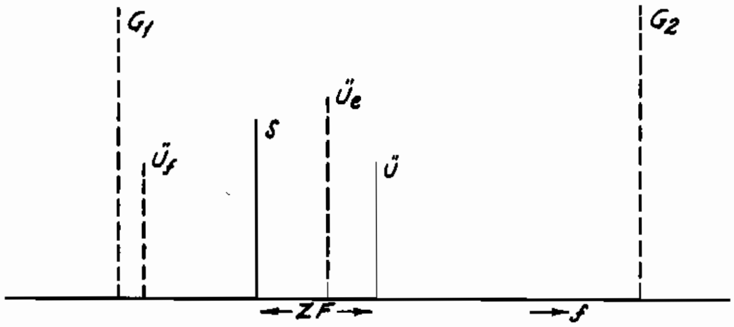

Fig. 4

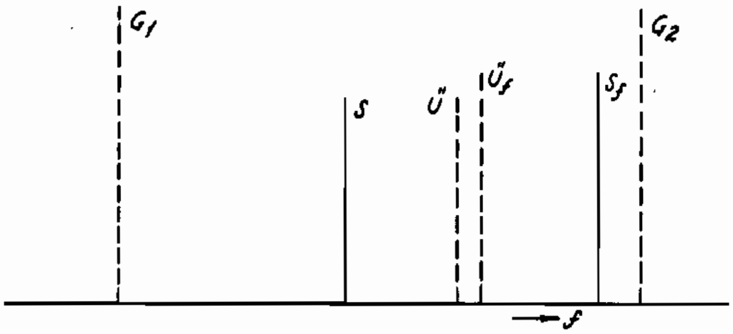

Fig. 6

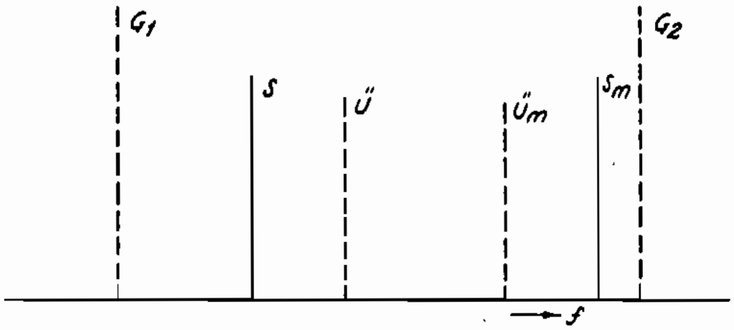

Fig. 5

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ALIEN PROPERTY CUSTODIAN

RECEIVER

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The invention relates to a tuning arrangement for receivers which can be used more especially for ultra-short waves and decimeter waves. It is known that in case of short waves it is no longer possible to achieve such a high degree of constancy of the frequency as in the case of longer waves, since changes in the relative distances of the tube electrodes caused by temperature variations, for instance, already have an essential influence upon the frequency which is not experienced in the case of long waves. Therefore, the frequency of a short wave transmitter inevitably fluctuates beyond the band width of the input circuit of the receiver such that reception stops or when resuming the communication cannot be realized at all. Furthermore, the same drawbacks are inherent in the oscillation generators employed as oscillators in superheterodyne receivers and thus the produced intermediate frequency deviates from the desired value not only on account of the variation of the transmitter wave, but also on account of the variation of the local oscillator frequency. In order to insure a safe operation means must therefore be employed which enable the receiver to receive waves which are unstable within a certain frequency range. Thus it has become known, for instance, to wabble frequency of the local oscillator of the receiver with a frequency lying beyond the audible limit, about a low value so that also the intermediate frequency fluctuates periodically about an average value. The permissible fluctuation width of the transmitter frequency however, is hereby extremely small with with the result that in most cases this arrangement is insufficient for practical purposes. Furthermore, it is known that the receiver can be sharply tuned in an automatical manner to the transmitter wave whereby disturbances caused by the lack of constancy of the transmitter wave, can also be avoided within narrow limits. But since the range of this automatic vernier tuning is very narrow, this arrangement fails also if for instance at the switching-in of the receiver, the transmitter wave lies outside the range of the vernier tuning.

In accordance with the invention an entirely safe reception of the desired transmitter is rendered possible in that a pendulum movement of the tuning organ of the receiver within which a frequency range will be swept which corresponds to the possible fluctuation range of the transmitter frequency, is automatically stopped at resonance of the receiver with the transmitter frequency and at the same time an arrangement for the automatic vernier tuning is switched-in.

This offers the advantage that the range of the automatic vernier tuning can be chosen as small as desired, i. e. its accuracy can be chosen extremely high, while wide fluctuations of the transmitter frequency or local oscillator frequency are still admissible.

The first-mentioned feature of the invention, namely the periodic vibratory movement of the tuning organ be termed "finding performance" denoting that the receiver next finds automatically the transmitter wave within a given range and holds on to this wave in this tuning stage at resonance with the transmitter wave. The second feature of the invention, namely, the automatic vernier tuning which can be carried out in any desired manner, serves for enabling the receiver to follow continuously eventual variations of the transmitter frequency.

It is readily seen that with the method of tuning carried out in accordance with the invention, the reception is always accomplished in exactly the same manner as in the case of the normal receiver so that all disturbances caused for instance by the wabbling of the local oscillator are eliminated. It should be remarked already at this place that the arrangement according to the invention is equally well effective whether in the case of variations of the transmitter frequency being received, or, in the case of using a superheterodyne receiver, at a variation of the frequency of the local oscillator. Since at ultra-short waves, superheterodyne receivers are often used and the transmitters can usually be given a constant frequency through a larger number of means, the last-mentioned case of the fluctuation of the local oscillator frequency will be the more frequent case.

The finding performance will next be elucidated in reference to Fig. 1. Item H represents the high frequency part and the mixer stage of a superheterodyne receiver to which is applied in addition to the receiving frequency, the local oscillator frequency of the oscillator O which is indicated only by an oscillatory circuit for the sake of simplicity. The intermediate frequency formed is amplified in the intermediate frequency part Z then demodulated and applied to the audio-frequency part N of the receiver. In order to find the transmitter wave being received, the tuning of the local oscillator O is moved reciprocally across a certain frequency range. To this end a motor M is provided which turns the variable condenser of the local oscillator up to a certain angle whereafter the polarity of the motor is reversed by means of a switch U which actuates the contacts *u*, so that the turnings of the condenser takes place in the other direction. If, for instance, the contact E which is coupled for example with the main switch of the receiver, is closed, the finding performance starts immediately irrespective as to whether or not a transmitter wave is present.

Now when the transmitter is being operated and the oscillator O assumes its correct position of tuning, i. e. the position in which an intermediate frequency appears to which the intermediate frequency amplifier is tuned, the current passing through the intermediate frequency tubes changes at this moment whereby the relay A which lies in the plate circuit of one or of all intermediate frequency tubes, will be actuated. The relay contact pertaining to A and which is placed in the circuit of the motor M and is closed in the position of rest, is designated by *a*. As soon as the correct resonance position of the receiver is attained, the contact *a* will be opened whereby the motor comes to a stop.

The starting of the finding performance at the switching-in of the receiver may be delayed until the receiver has reached the operative state, i. e. until the tubes are heated up. Furthermore, the finding performance may only then be started if it is ascertained in any desired manner that a receiving oscillation is present within the intermediate frequency range.

The mode of carrying out the finding performance according to the invention is not limited to the arrangement shown in Fig. 1; the reciprocating movement of the oscillator tuning may also be obtained by purely electrical means, for instance, with the aid of relaxation circuits through which an inductance, or a capacity has its value varied periodically. Furthermore, the potential which causes the stopping of the reciprocating movement may be derived at any desired plate of the receiver, and therefore also, for instance, at the high frequency part. In the case of a straight receiver the tuning of the receiver input circuit may, for instance, be varied periodically and this variation may be interrupted directly by the current of the high frequency tube.

A practical construction of the switch shown schematically in Fig. 1 is given by the example of Fig. 2. Herein is item A the shaft of the variable condenser of the tuning arrangement, which shaft is rigidly connected to a lever S and is coupled with a motor M not shown in the drawing. A stationary ring R is arranged concentrically to the shaft and on the said ring, two levers H_1 and H_2 which can be swung about the shaft A, can be tightened up in any desired positions by means of the clamping screws F. The levers H_1 and H_2 are loosely mounted on the shaft A and are equipped with the contacts K_1 and K_2. Now, if the shaft A is driven by the motor causing the lever S to turn, for instance, to the right, the latter arrives at the contact K_1 and actuates the latter which in turn actuates a pole reversing switch so that the latter reverses the direction of movement of the motor. Then the lever S turns in the other direction to the left until it reaches the contacts K_2 thereby again reversing the polarity of the motor, etc. The limits and the central position of the frequency range covered by the tuning organ can be set at will through separate adjustments of the contact levers H_1 and H_2. The positions of these levers are fixedly established preferably through various transmitters given in advance, or the lever positions are fixed in suitable points by means of corresponding stop organs. Obviously, also for the reversing arrangements various structural solution can be found all of which suited for practising the general idea of the invention.

As already pointed out the hitherto described finding performance is switched in simultaneously with the switching-in of the entire receiver, so that until the transmitter wave is found, the tuning organ is next periodically moved in a reciprocating fashion. If no transmitter frequency exists within the range of finding, the tuning organ carries out a continuous pendulum movement so that the absence of a transmitter carrier can be readily verified from the outside. If, however, a transmitter wave is present, the finding performance is stopped when the correct tuning position is reached. But since the transmitter frequency or local oscillator frequency does not remain constant, the receiver would very soon fall out of tis correct tuning position entailing the failing of reception. In order to avoid this condition there is inserted in accordance with the invention simultaneously with the switching-in of the finding performance, an arrangement for the automatic vernier tuning. This arrangement may be of any desired type and may be constructed in a manner known as such. It will, however, be advisable to employ for the automatic vernier tuning the same means as those employed for finding the transmitter wave as will be described in greater detail in the following. In order to gain a control voltage through which the receiver is always brought automatically into the correct position of tuning, there may be employed, in a manner known as such, two circuits which are detuned relative each other and which are placed for instance in the intermediate frequency circuit of the receiver and whose voltages are detected and connected in opposition. If the frequency applied to these circuits varies, also the control potential varies in an unequivocal fashion. Since when operating with ultra-short waves, frequency modulation is ordinarily employed, the arrangement for gaining the control potential can be advantageously used at the same time for the demodulation of the frequency modulated oscillations, since as is known, two relatively detuned circuits connected in opposition across detectors are in fact likewise suited to this end.

The control voltage now is applied, for instance, to a tube in whose plate circuit a differential relay is placed. At the mean frequency which corresponds to the required frequency, the relay contact is in its central position. When the frequency applied to the two circuits increases, the relay contact moves in the one direction, and when the frequency decreases, the said contact moves in the other direction. Now, if the relay is so placed in the circuit of the motor M shown in Fig. 1, that the relay contacts have different directions of rotation of the motors assigned thereto, the tuning of the oscillator O is Fig. 1, will be affected when a control potential appears. Now, if the dependence of the direction of rotation of the motor on the direction of the variation of the control voltage is chosen in such a sense whereby in the case of an increase of the frequency to be controlled a rotation of the motor in the direction of low frequencies takes place, the receiver will place itself always in the desired position of tuning. When the transmitter frequency changes, the receiver tuning follows in the proper sense.

In applying the general idea of the invention there is assured next the finding of the transmitter frequency lying at any desired place of the given range and furthermore, an always correct tuning of the receiver also in the case of fluctuations of this frequency.

As stated, the control voltage for the automatic vernier tuning can be derived from the intermediate frequency amplifier. In place of this, also all other known circuits are possible. In the same manner in which in the described example the finding performance and the automatic vernier tuning can be carried out with the use of the same drive motor, in a variation of the receiver tuning taking place in a purely electrical fashion the same means (for instance, relaxation circuits) may be employed both for the finding as well as for the sharp tuning.

If during the reception the frequency of the transmitter oscillation or of the oscillation of the local oscillator changes suddenly by such high values which cannot be followed-up by the automatic vernier tuning, the finding performance sets-in anew and continues until the transmitter wave is found again. It is hereby of advantage if the finding performance instead of being initiated instantaneously, is switched-in with a certain delay, since it happens often that the transmitter wave varies its frequency during a brief moment but later resumes again the same position. Thus, the stopping of the finding performance may, after reaching the correct tuning position, take place by means of an immediately responding relay, while the next switching-in is carried out by means of a special time delay relay A circuit of this type will be described later on hand of the Fig. 3. The time delay is hereby provided in a manner known as such, for instance, in that a bi-metal strip establishing the contact is passed by the current which initiates the finding performance, such that the contact will be closed only at sufficient heating.

In the operation with ultra-short waves, the distribution of the various transmitters and the ranges thereof across the frequency band are of particular importance. In order to avoid hereby disturbances of the receiver owing to the reflected frequencies, it is of advantage so to adapt the arrangement that the finding performance is finally stopped only when the frequency of the local oscillator lies at the one predetermined side of the transmitter frequency. This condition will be elucidated on hand of Fig. 4. In this figure the frequencies are plotted along the abscissa. Letter S is meant to indicate the normal position of the wave being received and Ü is the desired position of the frequency of the local oscillator of the receiver. Then the intermediate frequency ZF is obtained which would be plotted in the same way if the frequency of the local oscillator were at the place $Ü_f$. In order to avoid disturbances by reflected frequencies etc. it be required however, that the local oscillator operates in Ü. The letters G_1 and G_2 may represent the limits of the range covered during the finding performance. Now, the correct choice of the frequency of the local oscillator to be obtained automatically can be realized in that through suitable choice of the initial direction of rotation of the motor; the frequency of the local oscillator which may be at the place $Ü_e$, for instance, at the switching-in of the receiver, is always moved in the direction upon the limit G_2 at the switching-in of the receiver and away from this limit, whereby contact arrangements are provided in such a manner that the finding performance can be stopped only when the tuning was reversed once at the limit G_2. Therefore, if $Ü_e$ moves to the right, it cannot as yet be stopped at the place Ü but must first reverse its movement at the limit G_2 in order to enter the correct position of tuning Ü in arriving from the right and be fixed in this position.

As can be readily seen, it can then never happen that the finding performance will be interrupted in the tuning position $Ü_f$. In fact if $Ü_e$ is between the limits G_1 and $Ü_f$, for instance, and if, as is required, it moves initially to the right, it cannot be stopped neither in $Ü_f$ nor by Ü, but must first reverse its movement at the limit G_2 in order to arrive in the final position Ü from the direction of higher intermediate frequencies. If, however, $Ü_f$ is to be the desired position of the local oscillator frequency, while Ü is the wrong local oscillator tuning, the initial movement is to take place towards the left and the arrangement is to be so adapted that the finding performance can be stopped only after a reversal at the limit G_1. Then exactly the same conditions must be fulfilled as before.

If the transmitter frequency should have moved such a distance that the correct tuning position cannot be found at all within the range of finding the receiver cannot stay on a wrong tuning position because the automatic vernier tuning operates in the wrong direction in this case and the receiver moves out of its tuning position again. The hereby prevailing conditions are shown in Fig .5. The limits of the finding performance are again designated by G_1 and G_2 while S represents the normal position of the transmitter frequency and Ü is the correct position of the frequency of the local oscillator. Now, if the transmitter frequency moves towards the place S_m, the proper position of the frequency of the local oscillator would lie outside the limits of the finding range, namely, outside the limit G_2 and thus the receiver cannot move into this position.

On the other hand it would be possible that the receiver remains with the tuning of the local oscillator at the place $Ü_m$ because in this place the proper intermediate frequency is obtained with the transmitter frequency S_m. This condition could neither be prevented through the described method of fixing the receiver only when the tuning means has reversed at a limit of the range. But in this case the automatic vernier tuning operates in the wrong direction, i. e. when the frequency of the local oscillator approaches the place $Ü_m$ the control voltage acts in the sense whereby the tuning means is turned beyond the place $Ü_m$ so that $Ü_m$ is likewise not suited as final tuning position. This condition can serve for verifying the fact that the transmitter frequency or the receiver frequency has moved too far out, i. e. that the range defined by the limits G_1 and G_2 is too narrow.

A circuit fulfilling these conditions is shown in Fig. 3. Herein is M the motor and U is the reversing arrangement just as in the case of Fig. 1 whereby the said reversing arrangement acts upon the two contact pairs K_1 and K_2 in accordance with Fig. 2. As in Fig. 1, item A designates the relay which serves for the tuning position. The appertaining contact is designated by *a* which is closed at a wrong tuning or at the absence of the transmitter wave. Now it is assumed that the correct tuning position has not yet been reached and that, therefore, the contact *a* is closed. Consequently, the relay D will be actuated and closed its contacts d_1 and d_2. The relay D has placed in parallel thereto the time delay relay B*i* having the contact *bi* and which, as already stated, serves for causing the finding performance to start with a certain time delay. Otherwise this relay and its contact entirely correspond with the relay D.

As is seen, the motor M is now in operation receiving its feed voltage across the contacts b_3 and b_4 from the voltage source S*p*. The lever S of the reversing arrangement has hereby moved downwards. If the tuning passes at this movement a place in which a correct intermediate frequency appears, the contact a will be released. However, the rotation of the motor can hereby not as yet be interrupted, since the relay D maintains its position across its contacts d_1 and bi and across the contact b_2 which is closed in the position of rest thus retaining a conducting connection between the motor and the feed voltage source. Thus, the tuning arrangement moves beyond this position and arrives at the contact k_2 which it short circuits. Then the relay B will be energized and the contact b_1 will be closed, while the contact b_2 will be opened and the contacts b_3 and b_4 will be moved over. Meantime the contact a has closed again since the tuning has moved beyond the correct value of the intermediate frequency. The switching of b_3 and b_4 has the effect that the direction of rotation of the motor will be reversed whereby the lever S will be moved upwards. Also when the contact k_2 is open does the relay B hold its position across the contacts b_1 and d_2. Now, if a correct position of tuning is arrived at again, the contact a will be released and therefore, the motor circuit will be cut because the contacts b_1 and d_1 will be opened while b_2 was open in the first plaee due to the excitation of B and thus the relay winding D no longer receives current. As soon as D is released, d_2 will be opened so that B has no current while the contact b_1 will be opened and the contact b_2 will be closed. But the motor cannot start again since d_1 and b are open. Since owing to B being inactive, the contacts b_3 and b_4 return to the right into the position of rest, the initial state is realized again and the same performance begins again in exactly the same manner when the transmitter wave is interrupted.

If no transmitter wave can be found within the entire frequency range covered by U, the lever S moves to and fro between the contacts k_1 and k_2. A short circuit of k_2 results in a switching of the contacts b_3 and b_4 as already pointed out and these contacts remain in the left position since d_2 is closed in the position of rest and b_1 will likewise be closed when k_2 is short circuited. It is only when the lever S arrives in the other limit position and short circuits the contact k_1 that the winding B will be short circuited so that b_1 will be released and b_3 as well as b_4 return again to the position of rest. The direction of rotation of the motor will then be reversed.

With the circuit illustrated in Fig. 3 it can be accomplished in fact that only a single one of the possible positions of the frequency of the local oscillator with respect to the transmitter frequency leads to the stopping of the finding arrangement. The automatic vernier tuning will in no ways hereby be affected since the local oscillator is obviously always correctly controlled once it has been given its proper position. As already explained in connection with Fig. 4, in the case of a position of the frequency of the local oscillator at the other side of the transmitter frequency, the initial direction of rotation in Fig. 4 must obviously be upwards and the contacts k_1 and k_2 must be interchanged.

It will now be shown on hand of Fig. 6 that in applying the idea of the invention and in employing an additional means a substantial saving in the band width required for any transmitter is realized and that the transmitters can be placed nearer each other without mutual disturbance being encountered. If S represents again the transmitter frequency being received and if U designates the correct position of the local oscillator, the initial direction of rotation of the motor is to be such that the frequency of the local oscillator moves to the left at the beginning of the finding performance. Now, if a further transmitter frequency S_f exists within the limits G_1 and G_2, the danger exists that after reversing its movement at the limit G_2 the frequency of the local oscillator stops at the place $Ü_f$ where the same intermediate frequency will be formed as in Ü but this with the wrong transmitter so that the wrong transmitter will be received. However, the receiver cannot stop at the wrong transmitter wave, because in this case, as already stated, the control voltage of the automatic vernier tuning acts in the wrong direction and withdraws the tuning again from this position of tuning. The finding performance then starts anew until the wrong position of tuning is found again, etc. But the receiver can in no ways be brought beyond the wrong tuning position and into the range of the correct tuning position. Now, if care is taken that the disconnection of the finding performance can happen only when the frequency of the local oscillator approaches the correct intermediate frequency from the side of the higher intermediate frequencies while on the contrary the interruption of the finding performance is rendered impossible if the correct tuning is obtained from the side of the low intermediate frequencies, also the place $Ü_f$ cannot serve for the stopping of the finding arrangement such that the tuning moves beyond the said place and reaches the correct position Ü from the side of the higher intermediate frequencies.

This can be done easily, for instance, in that by means of potentials, derived from the one of the two circuits for the automatic vernier tuning, tuned, for instance, to the higher frequency, which circuits are detuned relative each other, relay contacts are prepared in such a manner that they lead to the stopping of the finding performance only when potentials are actually applied to the said circuit, i. e. when the intermediate frequency has been brought to the center position from the side of the tuning of this circuit.

Finally in many cases not further described herein for the sake of simplification, an automatic exclusion of wrong transmitter frequencies lying within the range of finding can already be accomplished solely by the automatic vernier tuning, since at the stopping of the finder arrangement at a wrong tuning position, the vernier tuning acts in the wrong direction as soon as it begins operating, as a result of which the finding performance will be switched-in again whereby the correct transmitter wave will then be found automatically. In order to contribute to this action it is of advantage instead of stopping the finding performance exactly at resonance frequency to have it cease at a place lying at a short distance from said resonance place inside the range of the vernier tuning in order that in any event the automatic vernier tuning will be put in operation. In view of the speed of the entire switching performances this does not involve any appreciable delay of the tuning performance.

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