Feb. 14, 1933.

J. E. GARDNER

1,897,252

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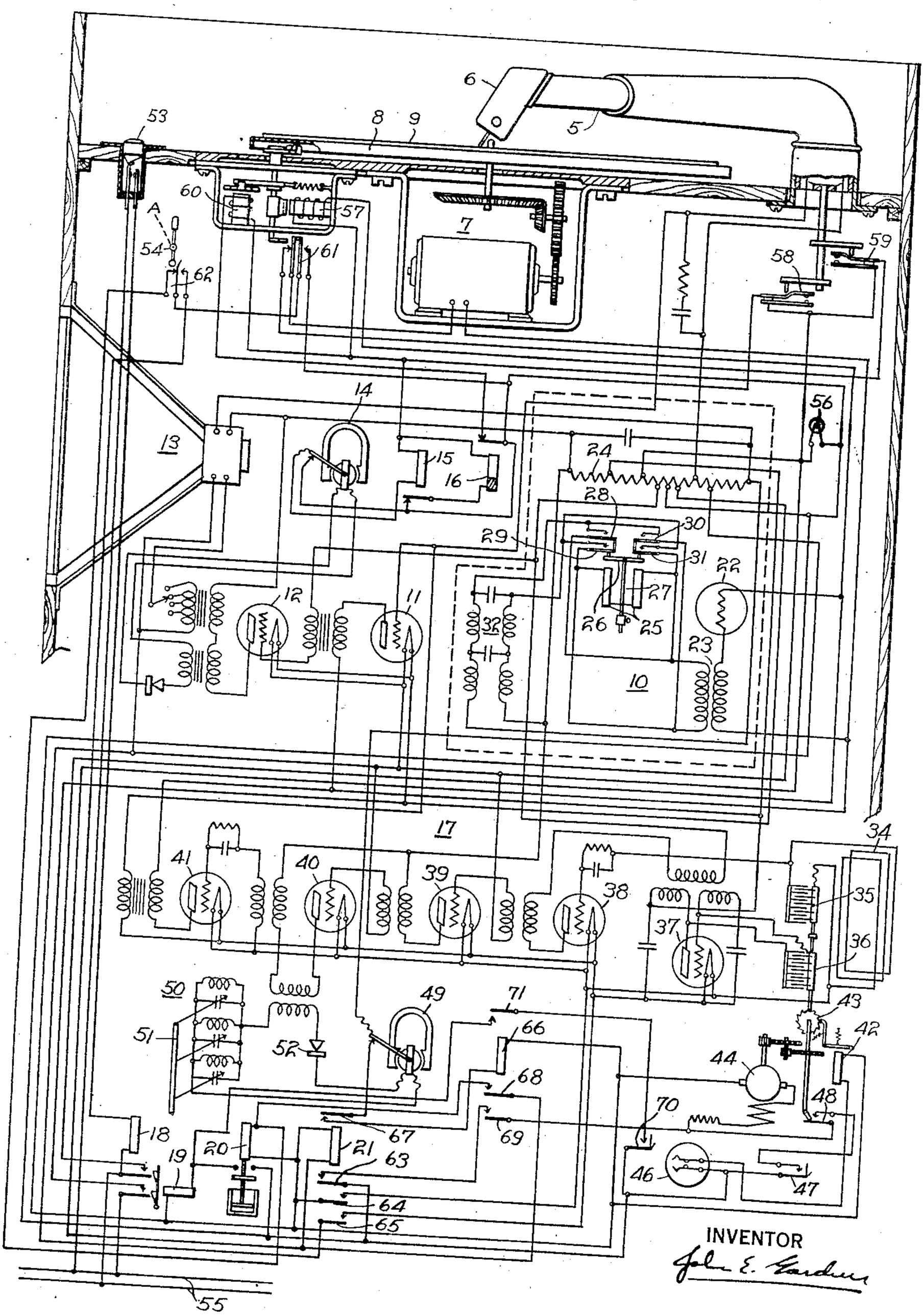
Filed Aug. 23, 1926



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Patented Feb. 14, 1933 1,897,252

UNITED STATES PATENT OFFICE

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RADIO RECEIVING SYSTEM

Application filed August 23, 1926. Serial No. 130,807.

My invention relates in general to talking machines, and more particularly to such machines as employ a radio receiving set in conjunction with a phonograph.

One of the objects of my invention is to provide improved automatic means associated with the radio receiving unit for automatically selecting any radio station that happens to be on the air at the time the receiving set is operated.

Another object is to provide improved means for pre-selecting a radio broadcasting station so that it will be the one selected by the automatic tuning means referred to.

Another object is to provide automatic tuning means of the type mentioned which will function without any interference from the so-called static.

A further object is to provide an improved magnetic rectifier that will operate to efficiently change alternating current as supplied from commercial source to direct current, suitable for use in the talking machine.

There are other objects of the invention which together with the foregoing will be described in the detailed specification that is to follow, taken in conjunction with accompanying drawing forming a part hereof.

In practicing my invention, I provide a talking machine of a well known type. I also provide various relays for performing the automatic tuning function and certain other features. These switching devices have been described more in detail in my co-pending application, Serial Number 123,528, filed July 19th, 1926, and in my co-pending application, Serial Number 129,717, filed August 17th, 1926.

In the drawing I have shown by means of the usual conventional diagrams, sufficient of the apparatus and circuits to enable my invention to be readily explained and understood.

Referring to the drawing, the talking machine comprises the usual tone arm 5, magnetic pick-up 6, electric motor 7, turn table 8, and record 9. Other portions of the talking machine comprise a power unit 10, amplifiers 11 and 12, loud speaker 13, milliammeter voice current relay 14, controlling relays 15 and 16, radio receiving set 17, connecting and disconnecting relays 18 and 19, and controlling relays 20 and 21. All of this apparatus, as well as the operation thereof, with the exception of the power unit 10, and the radio receiving set 17, has been described in detail in my co-pending application, Serial Number 129,717, filed August 17th, 1926, and this description need not be repeated here.

The power unit 10 comprises a ballast tube 22, that is merely a current limit reactance and transformer 23, and a resistance 24, that acts as a potentiometer. The rectifying device proper comprises a relay 25 of the type ordinarily employed in the harmonic converters in the automatic telephone art. This relay is provided with a polarized armature 26, having a pendulum 27 attached thereto. This pendulum is adjusted so that the armature is resonant to a frequency of 60 cycles. The armature actuates springs 28 and 29 in one position, and 30 and 31 in another position.

A filter circuit 32 is associated with this rectifier so that a direct current having a substantial constant voltage and wave shape is obtained. This filter may be of any well known construction.

The radio receiving set is of the superheterodyne type, and it comprises a loop antenna 34, tuning condensers 35 and 36, oscillator triode 37, first detector triode 38, intermediate amplifiers 39 and 40, and second detector 41.

The condenser 35 is adapted to control the tuning of the input circuit of the first detector 38, while the condenser 36 is adapted to control the frequency of the oscillations generated by the oscillator 37.

It is well known that there is a definite relation between the frequency of the incoming signal and the frequency of the oscillator for the best results in superheterodyne amplifiers. It has been found that an intermediate frequency of 40,000 cycles gives very desirable results in amplification. Various types of one dial control superheterodyne radio sets have been placed on the market. By means of these both the condenser that controls the frequency of the oscillator are controlled by

one dial; the condensers being geared so that when any station is tuned in the intermediate frequency will be say 40,000 cycles.

It has also been found that for the reception of some incoming frequency, a greater efficiency of amplification may be secured by using another intermediate frequency. This relation of the two condensers is controlled by their gearing, so that the proper frequency of oscillation is generated to bring about the formation of the proper intermediate frequency. Condensers 35 and 36 of the radio receiving set 13 are geared together so as to produce these results.

These condensers are adapted to be operated by a stepping magnet 42 through a pawl and ratchet device 43. The condensers are also adapted to be operated by a motor 44 through a reducing gearing 45. The reducing gearing 45 is so constructed that when the motor is operated, the condensers are actuated very slowly. The stepping magnet 42 is adapted to operate by means of the calling device 46. This calling device may be of any well known type employed in the automatic telephone art, though it is so modified to close the circuit instead of open it, a large number of times. The number of impulses that are sent out by the calling device is controlled by the degree of nicety required in adjusting the condensers 35 and 36.

It has been found that if the calling device is adapted to send out 100 impulses for one revolution, and the ratchet and pawl arrangement 43 of the stepping magnet 42 are arranged so as to advance the condensers 35 and 36 to 180 degrees, that this will be satisfactory for most purposes.

The call letters of any particular station may be placed in the finger holes in the dial, or any such position where the operator may actuate the calling device for the required number of impulses, and release key 47 is associated with the calling device and controls the restoration of the condensers 35 and 36 to a normal predetermined position. This operation is brought about by a cam switch 48, which actuates a pair of springs when this normal predetermined position is reached.

The output circuit of the last intermediate amplifier 40 is associated with the milliammeter relay 49 through a band filter 50. The band filter may be of any well known type, and is adjusted so as to be resonant only to the particular intermediate frequency that is used for intermediate amplification of any station that happens to be tuned in. As this frequency may vary, as explained hereinbefore, means are provided for adjusting the frequency to which the band filter is responsive through the shaft 51, which is operated by means of the motor 44.

In this manner when a station is tuned in, the band filter 50 is adjusted so that it is only responsive to the particular intermediate frequency that is the best for the station selected. A small rectifier or detector 52 is connected in series with the milliammeter relay 49 in order to rectify the currents in the circuit of the armature of the milliammeter relay.

A push button key 53 is provided for connecting energy to the talking machine. A single throw key 54 is provided for controlling the initiating of the automatic tuning of the device, as will be explained.

Having briefly described the apparatus shown in the drawing, I will now explain its detailed operation. If the operator desires to play the phonograph alone, he will operate the push button 53 and the key 54 into position A. The operation of the key 53 completes a circuit for the alternating relay 18. Alternating relay 18 operates to attract its armature, thereby connecting the alternating current energy from the source 55, through the primary of the transformer 23. The armatures of the relay 28 are latched in operative position by the armature of the relay 19 by the flow of alternating current through the primary of the transformer 23, and alternating current is induced into the secondary of a voltage which is determined by the relative number of turns of one winding to the other. This voltage is determined by the proper voltages necessary to operate the talking machine. When alternating current is induced into the secondary of the transformer 23, the harmonic relay 25 is operated.

To explain the operation of the rectifier, the operation will be described when there is a positive wave of alternating current induced into the secondary. Inasmuch as the armature 26 of the relay 25 is polarized, this armature will swing in such direction as to force the springs 28 and 29 into engagement with their working contacts. A circuit may now be traced that extends from the lower end of the transformer 23 spring 29 and its working contact filter 32 to one side of the potentiometer, while the other portion of the circuit extends from the upper side of the transformer 23 spring 28 and its working contact filter 32, to the other side of the potentiometer 24. When there is a negative wave in the secondary circuit, the relay 25 operates its armature 26, so that the springs 28 and 29 are opened, and the springs 30 and 31 are forced into engagement with their working contacts.

It will be seen that the connections of the secondary of the transformer 23 with respect to the potentiometer 24 are reversed under these conditions. This reversal occurs with each half wave of the alternating current, so that the current always flows in the same direction to the two terminals of the potentiometer. The relay 25 thus functions as a rectifier. Inasmuch as the armature 26 of

relay 25 is tuned to a frequency of 60 cycles, its operation will be synchronous with the reversal in polarity in the alternating current, so that full wave rectification is secured with very high efficiency.

The filter 32 functions to smooth out the wave, so as to form a continuous current out of an impulsing direct current that is obtained from the rectifier. The potentiometer 24 is employed so that various voltages may be obtained, the mid-point of the potentiometer being zero potential.

It will be understood that any other form of rectification may be employed in place of the one described. As soon as the rectifier begins to function, the lamp 56 is energized to apprise the operator of the connection of electric energy to the talking machine. It will then release the key 53, thereby opening the circuit of the relay 18. This result is without function, because the armatures of this relay are latched in their operated position when record 9 is placed upon the turn-table 8, and the tone arm moves so that the needle in the magnetic pick-up 6 engages the first groove in the record, and re-set magnet 57 is operated to initiate the rotation of the turn-table.

Loud speaker 13 is operated to reproduce the sounds recorded on the record. The milliammeter relay 14 is operated to open its contacts so long as there are sound currents present in the output circuit of the amplifier 12. Shortly before the end of the record, the tone arm causes the operation of a set of contacts 58 so that the slow acting relay 16 is energized. When the record is ended, sound waves are no longer present in the output circuit of the amplifier 12, and the milliammeter relay 14 is de-energized to permit its contacts to energize, thereby closing the circuit for the relay 15. The relay 15 is energized to open the circuit of the slow acting relay 16, which is de-energized after a short interval of time, to complete a circuit for the release magnet 60. The release magnet 60 operates to stop the record, and disconnect energy from the motor 7.

Another result of the operation of the release magnet is that a circuit is closed for the slow to operate relay 20. If no other record is played, slow to operate relay 20 is energized for a considerable period of time to complete a circuit for the relay 19, which operates to disconnect electric energy from the talking machine.

If the operator plays another record, the operations proceed in the manner described.

All the above operations have been described more in detail in my co-pending application, Serial Number 129,717 filed August 17th, 1926, to which reference is made if a more complete explanation is desired.

If the operator desires to listen to the radio after the record is played, the key 54 is placed in position A. Now, when the end of the record is reached, and the release magnet 60 is operated, a circuit is completed that extends from the connection on the potentiometer, springs 58, springs 61, working contact of spring 62 and said spring relay 21, to the mid-point on the potentiometer. The relay 21 is energized to prepare a circuit for the motor 44 at armature 63, and to complete circuits for energization of the filaments of the triodes 37 to 41 inclusive, at armatures 64 and 65.

Another result of the operation of the relay 21 is that at armature 67 a circuit is completed that extends from a connection upon the potentiometer through the springs of the milliammeter relay 49, armature 67 and its front contact, relay 66 to the midpoint of the potentiometer. The relay 66 is energized over this circuit and operates to complete a circuit for the slow to operate relay 20 at armature 68 and to complete a circuit at armature 69 for the motor 44 over a path that extends from one connection on the potentiometer, motor 44, armature 69 and its front contact, front contact and armature 63 to the midpoint of the potentiometer. The motor 44 is operated over this circuit to move the rotors of the condensers 35 and 36 slowly. The operation of the motor 44 also causes the movement of the shaft 51 controlling the tuning of the band filter 50.

By the energization of the filaments of the triodes 37 to 41 inclusive the radio receiving set 17 is energized so that it will respond to an incoming signal. By the energization of the filament of the triode 37 this triode generates an oscillating current the frequency of which is controlled by the condenser 36. When the condenser 35 is adjusted so that the input circuit of the detector 38 is resonant to the frequency of the broadcasting station the rotor of the condenser 36 will be in such position so that the proper local oscillation is set up by the oscillator 37 so that the heterodyne beat wave is formed having the desired frequency for maximum amplification. With the condensers 35 and 36 in this position the wave filter 50 will be tuned to respond only to the beat frequency. This beat frequency is amplified by the operation of the amplifiers 39 and 40 and such other amplifiers as may be connected in the circuit. It will be seen that the output circuit of the last amplifier 40 is connected to the milliammeter relay 49 through the band filter 50. The amplified intermediate frequency is thus applied to the band filter, and as this band filter is tuned for this frequency current flows in the armature of the milliammeter relay 49. The relay 49 is so adjusted that an amount of current sufficient to operate it requires that the station be tuned in properly. When the relay 49 responds the circuit of the relay 66 is opened and the latter relay is de-

energized to open the circuit of the motor 44 at armature 69 and to open the circuit of the relay 20 at armature 68. The motor 44 immediately ceases to operate and the condensers 35 and 36 remain in the position in which they are set with the station tuned in.

The amplifiers 11 and 12 operate to amplify the sound waves from the broadcasting station and apply them to the loud speaker 13. The relays 14, 15 and 16 are operated at this time but their operation is without particular function. When the station signs off the relay 49 is immediately deenergized as the carrier wave from the broadcasting station is shut down and there is no intermediate frequency present in the radio receiving set. The deenergization of the relay 49 completes a circuit for the relay 36. The relay 36 operates to again close the tuning circuits. Another station is automatically tuned in in the same manner as described. If no other station happens to be broadcasting at this time the slow to operate relay 20 will be finally energized to complete a circuit for the relay 19 and operates to disconnect the electrical energy from the talking machine.

A slight modification of the automatic tuning equipment associated with the radio set gives a somewhat more preferable operation. In this instance the radio receiving set is adapted to operate with only one intermediate frequency, this frequency being the frequency at which optimum intermediate amplification is secured. The band filter 50 is then tuned so as to respond only to this frequency. The tuning of the band filter is not under these conditions controlled by the motor 44. With the equipment arranged in this manner, unless a broadcasting station is exactly tuned in by the automatic tuning equipment, the intermediate frequency will not be exactly that to which the band filter 50 is responsive. Until the intermediate frequency corresponds to this frequency which the band filter 50 is responsive the relay 49 will not be operated. When the station is properly tuned in the relay 49 will respond and the operations will occur substantially as described.

It sometimes happens that the operator desires to tune in a particular station. In order that he may do this a calling device 46 is provided together with a key 47. This calling device may be located on the talking machine or at a point remote therefrom. As mentioned before, the calling device is provided so that it may send a hundred impulses. The various stations are so designated on the calling device that it may be properly operated to send out a number of impulses which will set the condensers 35 and 36 in approximate position to tune in the required station. The release key 47 must be operated before the calling device 46 is operated. By the operation of the release key a circuit is completed for operating the magnet 42 as a buzzer until the condensers 35 and 36 are brought to a predetermined normal position. When the condensers are in this position a certain fixed number of impulses from the calling device 46 will place the condensers in the proper position for tuning in the particular station. When the calling device is operated in accordance with the code the stepping magnet 42 is energized successively a plurality of times until the condensers are brought into the desired position.

Now, when the automatic tuning device of the radio receiving set is operated by the energization of the relay 66 as before described, the first station that will be tuned in will be the one which is approximately selected by the setting of the condensers. The tuning in of this station proceeds in exactly the same manner as has been described.

The operator sometimes desires to disconnect energy from the talking machine when a particular radio station signs off. In order to accomplish this result a key 70 is provided. The key 70 is thrown after a particular station is tuned in. Now, when the selected station ceases to broadcast the carrier wave is no longer sent out and the relay 49 is deenergized to complete a circuit for the relay 66. The relay 66 is operated to initiate the automatic tuning and to complete a circuit at armature 71 for the relay 19. The relay 19 is energized to disconnect electrical energy from the talking machine in the manner described. During any of the radio receiving operations the operator may play the phonograph by moving the tone arm into position to play another record. The movement of the tone arm causes the energization of the reset magnet 57 which opens the circuit of the relay 21. The relay 21 is deenergized to disconnect the radio receiving set.

It will be seen that the normal condition of the talking machine is such that the radio set may be immediately operated as soon as the push button 53 is operated. This is true because the tone arm will be in its innermost position and the reset magnet 57 will not be energized nor will its armature be latched in an operative position. Therefore, as soon as energy is connected to the talking machine the relay 21 will be energized to connect the radio receiving set and the operation will proceed as before described.

Attention is directed to the fact that when the key 70 is operated after a radio broadcasting station is tuned in and the radio station signs off, the electrical energy will be immediately disconnected from the radio receiving set. Inasmuch as the relay 49 is operated at the last stage of intermediate amplification a considerable amount of current will flow through its armature and it will efficiently operate to perform the functions described. The relay 49 is energized all the

while a broadcasting station is tuned in until the station's carrier wave ceases. The relay is not affected by any change in the modulation from the station nor is it dependent upon sound currents.

It will be understood that while I have shown one embodiment of my invention and a means for carrying it out I do not wish to be limited to the specific means employed but desire to protect by Letters Patent such changes, deviations and modifications as come within the scope of the appended claims.

I claim:

1. A radio receiving set comprising in combination, means for receiving radio frequency oscillations, means for producing local oscillations and combining the local oscillations with the received oscillations to create oscillations of a different frequency, means for tuning the receiving set to render it responsive to received radio frequency oscillations having a definite frequency, and means controlled by the oscillations of said received definite frequency to control said tuning means.

2. A radio receiving set comprising in combination, means for receiving radio frequency oscillations, means for producing local oscillations and combining the local oscillations with the received oscillation to create oscillations of a different frequency, means for automatically tuning the receiving set to render it responsive to received radio frequency oscillation having a definite frequency, and means controlled by the oscillations of said different frequency to control said tuning means.

3. A radio receiving set comprising in combination, means for receiving radio frequency oscillations, means for producing local oscillations and combining the local oscillations with the received oscillations to create oscillations of a different frequency, means for amplifying said different frequency oscillations, means for tuning said receiving set to render it responsive to received radio frequency oscillations, having a definite frequency, and means controlled by said amplified oscillations for operating said tuning means.

4. A radio receiving set comprising in combination, means for receiving radio frequency oscillations, means for producing local oscillations and combining the local oscillations with the received oscillations to create oscillations of a different frequency, means for tuning said receiving set to render it responsive to received radio frequency oscillations having a definite frequency, and means including a relay device responsive to said different frequency oscillations for controlling said tuning means.

5. A radio receiving station comprising in combination, a circuit for receiving radio frequency oscillations, tuning means for altering the periodicity of said circuit, a receiving device for converting electrical oscillations to audible waves means for producing local radio frequency oscillations and combining them with the received radio oscillations to create intermediate frequency oscillations, means for causing said intermediate frequency oscillations to operate said receiving device and means for causing said intermediate frequency oscillations to control said tuning means.

6. A radio receiving station comprising in combination, a circuit for receiving radio frequency oscillations, tuning means for altering the periodicity of said circuit, a receiving device for converting electrical oscillations to audible waves, means for producing local radio frequency oscillations and combining them with the received radio oscillations to create intermediate frequency oscillations to operate said receiving device and means including a relay responsive to said intermediate radio frequency oscillations for controlling said tuning means.

7. A radio receiving station comprising in combination, a circuit for receiving radio frequency oscillations, tuning means for altering the periodicity of said circuit, a receiving device for converting electrical oscillations to audible waves, means for producing local radio frequency oscillations and combining them with the received radio oscillations to create intermediate frequency oscillations to operate said receiving device, a motor for operating said tuning means and means for causing said intermediate frequency oscillations to control said motor.

8. A radio receiving station comprising in combination, a circuit for receiving radio frequency oscillations, tuning means for altering the periodicity of said circuit, a receiving device for converting electrical oscillations to audible waves, means for producing local radio frequency oscillations and combining them with the received radio oscillations to create intermediate frequency oscillations to operate said receiving device, a motor for operating said tuning means, and a relay responsive to said intermediate frequency oscillations adapted to control said motor.

9. A radio receiving station comprising in combination, a circuit for receiving radio frequency oscillations, tuning means for altering the periodicity of said circuit, a receiving device for converting electrical oscillations to audible waves, means for producing local radio frequency oscillations and combining them with the received radio oscillations to create intermediate frequency oscillations to operate said receiving device, a motor for operating said tuning means, a relay responsive to said intermediate frequency oscillations to control said motor, and

means including a wave band filter for applying said intermediate frequency oscillations to said relay.

10. A radio receiving station comprising in combination a circuit responsive to radio frequency oscillations, means for producing local radio frequency oscillations and combining them with received radio frequency oscillations to produce a heterodyne oscillation, tuning means for altering the periodicity of the circuit responsive to radio frequency oscillation and the frequency of the local generated radio frequency oscillation arranged so that when the receiving circuit is responsive to a certain periodicity a predetermined heterodyne frequency will be produced and means responsive to said predetermined frequency for controlling said tuning means.

11. A radio receiving station comprising in combination a circuit responsive to radio frequency oscillations, means for producing local radio frequency oscillations and combining them with received radio frequency oscillations to produce a heterodyne oscillation, tuning means for altering the periodicity of the circuit responsive to radio frequency oscillation arranged so that when the receiving circuit is responsive to a certain periodicity a predetermined heterodyne frequency will be produced and means including a relay device responsive to a predetermind heterodyne frequency to control said tuning means.

12. A radio receiving station comprising in combination a circuit responsive to radio frequency oscillations, means for producing local radio frequency oscillations and combining them with received radio frequency oscillations to produce a heterodyne oscillation, tuning means for altering the periodicity of the circuit responsive to radio frequency oscillation arranged so that when the receiving circuit is responsive to a certain periodicity a predetermined heterodyne frequency will be produced, means responsive to a predetermined heterodyne frequency for controlling said tuning means and auxiliary means for controlling said tuning means to limit the operation of the means responsive to heterodyne frequency to a definite predetermined periodicity of said receiving circuit.

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