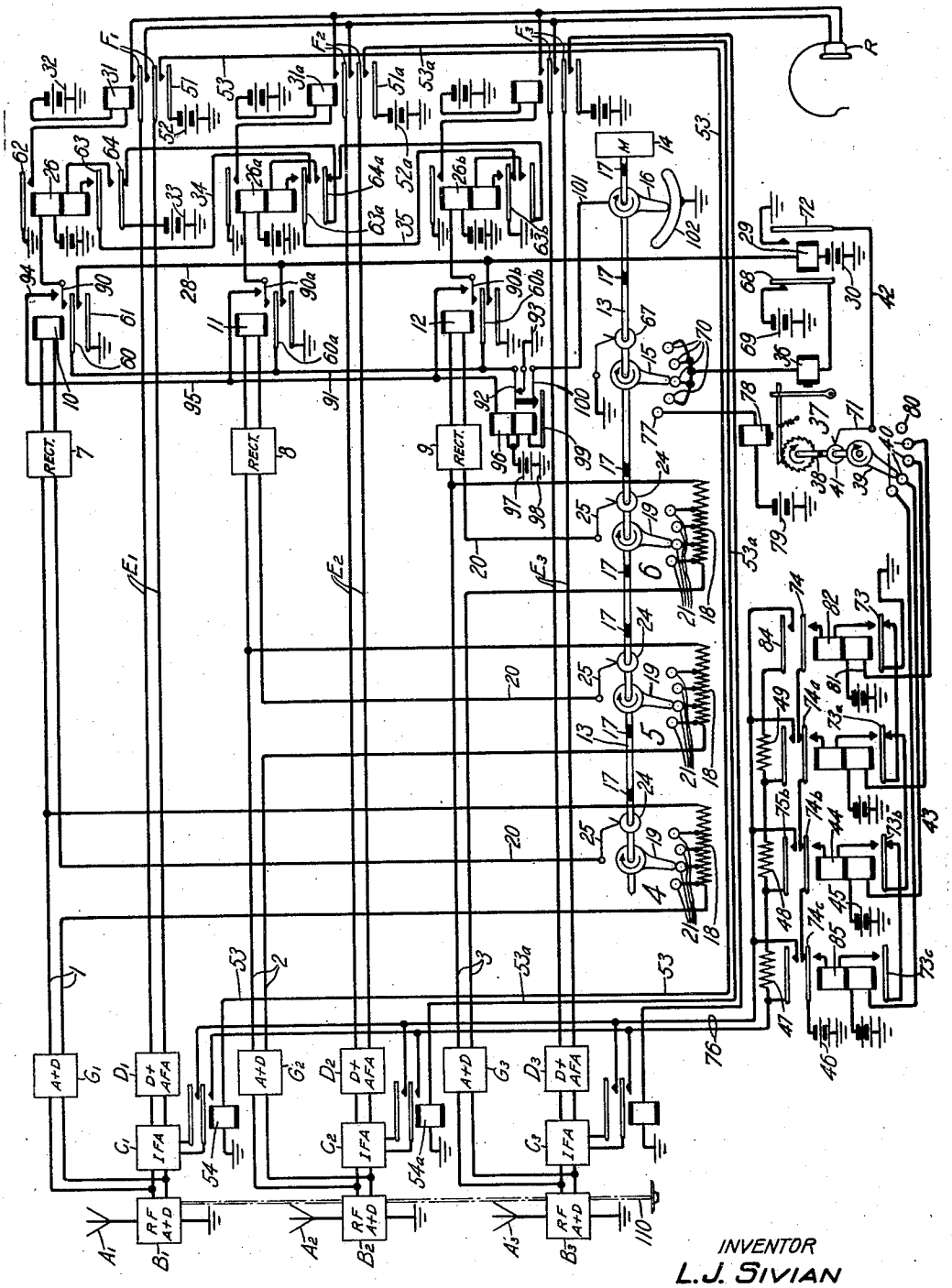
June 10, 1930. L. J. SIVIAN 1,763,194

COMMUNICATION SYSTEM

Filed March 23, 1929



Patented June 10, 1930 1,763,194

UNITED STATES PATENT OFFICE

LEON J. SIVIAN, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

COMMUNICATION SYSTEM

Application filed March 23, 1929. Serial No. 349,335.

This invention relates to communication systems and particularly to methods of and means for selecting and utilizing a particular wave from a group of associated waves.

One object of the invention is to select one wave of a group of waves, having the same or different frequencies, the amplitudes of which vary between relatively wide limits.

Another object is to permit the selection of the wave having the largest amplitude from a group of associated waves.

A feature of the invention relates to means whereby the apparatus, which at any given instant is receiving the selected wave, has its gain control adjusted in accordance with the absolute strength of the selected wave.

While the invention may be advantageously applied to any communicating system in which it is desired to select between waves of widely varying amplitudes, it is especially adapted for use in the radio field. For this reason, the invention will be hereinafter described as applied to a radio receiving system.

One cause of inefficiency in the transmission of intelligence by means of radio waves, particularly short waves, is fading, that is, variations in the strength of the incoming waves. It has been found that considerable differences occur in the fading effects at receiving antennæ separated by even a relatively few wave lengths of the received wave. As a result of this phenomenon, it has been proposed to utilize the energy supplied by a group of antennæ, so located with respect to one another that fading effects are different, to automatically select one antenna of the group and connect a radio receiver associated therewith to a line.

One difficulty often encountered in selecting one antenna of a group is that the amplitudes of the waves received by the respective antennæ vary temporarily between relatively wide limits. This characteristic makes the problem of selection a very difficult one.

In a specific embodiment of this invention, for use in a radio receiving system, there are employed a plurality of antennæ adapted to receive the same wave and so located relatively to one another that the fading conditions vary differently thereat.

Associated with each antenna is a radio receiver in which the received signal waves are amplified and detected. The output energy produced by a unit of each receiver, for example a high frequency detector included therein, is supplied to two branch circuits.

One branch leads to a switch whereby the output circuit of the radio receiver is connected to a low frequency signal receiving circuit. The other branch is connected to a device including a variable gain control mechanism and a marginally responsive relay for controlling the operation of the connecting switch.

Periodically, the variable gain control mechanisms are operated to simultaneously vary the transmission of the individual waves from a minimum to a maximum. As this variation takes place, the output of the unit associated with that antenna in which, at the instant, the amplitude of the received wave is the greatest will first reach a value sufficiently high to operate its marginal relay.

Operation of the marginal relay connects the output of the corresponding receiver to the signal frequency circuit. When this connection has been completed the switching circuits of the other receivers are rendered inoperative until substantially the beginning of a new selecting period.

If at another period of operation of the gain control mechanisms, the wave incident upon one of the other antennæ has the greatest amplitude, the connecting switch will be operated in a similar manner to connect the output circuit of the radio receiver associated with that antenna to the signal frequency circuit.

A gain control mechanism is provided which is adapted to be associated with the selected receiver. At each operation of the marginal relay, this mechanism will operate to adjust the gain to a value determined by the amplitude of the wave incident upon the antenna coupled to the selected receiver.

The principles of the present invention, together with its organization, mode of operation and advantages will be apparent from the following description read in conjunction with the attached drawing. The single figure illustrates a radio station embodying three complete radio receivers and control mechanism therefor.

The system comprises three circuits each including an antenna A_1 A_2, or A_3, coupled to a radio frequency amplifier and a detector which, respectively, amplify and step down the frequency of the incoming wave. These high frequency amplifiers, which may include any desired number of stages, and the detectors may be of any well known type and hence are, respectively, indicated by the blocks B_1, B_2 and B_3.

The stepped down, or intermediate frequency, waves produced by the apparatuses B_1, B_2 and B_3 are supplied to two paths. One path includes the respective intermediate frequency amplifiers C_1, C_2 and C_3, which may be of any well known type and may embody any number of stages.

Each of the amplified intermediate frequency waves is supplied to a detector with which is associated an audio frequency amplifier. Since the detectors and associated amplifiers may be of any well known type, they are indicated by the blocks D_1, D_2 and D_3, respectively. Obviously the audio amplifiers may each comprise any number of stages.

The audio frequency amplifiers are, respectively, connected by circuits E_1, E_2 and E_3 to switch contacts F_1, F_2 and F_3 any one of which may be closed to complete the circuit to a receiving device R, herein shown, by way of example, as a telephone receiver. Obviously, a loud speaker or any other receiving device may be used. Moreover, the receiving device may be located at the radio receiving station or at a remote station.

If the system is employed for telephony, the selected radio receiver may be connected over a telephone system to a local or distant subscriber.

The second path connected to the output circuit of each of the high frequency detectors B_1, B_2 and B_3 includes an amplifier-detector combination G_1, G_2 or G_3, respectively, which may be of any well known type.

The detectors of units G_1, G_2 and G_3 are connected through a circuit 1, 2 and 3, respectively. Each circuit is provided with a variable attenuator or gain control device 4, 5 or 6 adapted to be included in the respective input circuits of rectifiers 7, 8 and 9 during the selecting periods.

The rectifiers 7, 8 and 9 supply rectified current to marginal relays 10, 11 and 12, respectively.

The variable attenuators or gain control devices 4, 5 and 6 have their control arms mounted upon a shaft 13 driven by a motor 14. This shaft also carries the control arm 15 of a step-by-step control mechanism, and a contact arm 16, the functions of which will be described later.

The shaft 13 is provided with insulating sections 17, by which the gain control devices 4, 5 and 6, the contact arms 15 and 16 and the motor 14 are insulated from each other.

Any suitable source of alternating or direct current, not shown, may be used to supply energy for continuously operating the driving motor 14.

The gain control devices 4, 5 and 6 constitute a means for controlling the selection of one of the radio receivers.

Each control device comprises a resistance 18 connected across the circuits 1, 2 and 3. Each resistance 18 has one terminal connected to one side of the input circuit of the associated rectifier and is provided with several taps which are adapted to be connected through arm 19 and conductor 20 to the other side of the rectifier input circuit during the selecting periods.

The sections of the resistances 18, between corresponding taps, are of equal value. The taps are connected to contacts 21, adapted to be successively engaged by the arms 19.

Contacts 21 of the devices 4, 5 and 6 are concentrated in a small arc of the circle swept by the arms 19. Selection, therefore, takes place once during each revolution of the arms 19, and the selection period is confined to a very limited portion of the time required for these arms to execute a complete cycle.

The length of the selecting period and its relation to the time required for a complete revolution of the arms 19 is determined by the degree of concentration of the contacts 21 and the speed of the motor 14. Hence, by selecting the length of the arc within which the contacts 21 lie and by controlling the speed of the motor 14, the rate of recurrence of the selecting periods and the actual time required to effect selection may be regulated within reasonable limits.

If the antennæ A_1, A_2 and A_3, the units B_1, B_2 and B_3 and the units G_1, G_2 and G_3 have identical operating characteristics, the amplitudes of the detected currents, supplied by the detectors of G_1, G_2 and G_3, will correspond in value to the amplitudes of the waves incident upon the respective antennæ A_1, A_2 and A_3.

In order to compensate for any change in the general energy level of the waves received at the three antennæ, it may be necessary to change the gain of the associated receiving circuits. Such control can be accomplished by varying the gain of the

radio frequency or intermediate frequency amplifiers included in the respective receivers. For readily effecting this control, without disturbing the identity of the operating characteristics of the receivers, a unit control 110 is herein shown as applied, by way of example, to the radio frequency amplifiers.

The selecting operation is effected as follows, it being assumed, of course, that the motor 14 is in operation.

With the arms 19 out of engagement with the contacts 21 the input circuits of the rectifiers 7, 8 and 9 are open-circuited.

When the arms 19 engage the extreme right contacts 21 the right hand section of each resistance 18 will be included in the respective input circuit of the rectifiers 7, 8 and 9, and the voltages, produced by the flow of detected currents through these sections, will be applied to the respective rectifiers.

As the arms 19 rotate they successively engage the contacts 21 to connect additional sections of resistances 18 to the input circuits of the rectifiers. The input voltage applied to the rectifiers is thereby stepwise increased. The corresponding sections of the resistances 18 being equal, the voltages applied to the respective rectifiers 7, 8 and 9 and hence the rectified current supplied to the relays 10, 11 and 12 will be directly proportional to the amplitudes of the currents supplied by the respective detectors G_1, G_2 and G_3.

Let it be assumed that the arms 19 pass the extreme right hand contacts 21 without causing operation of either of the relays 10, 11 or 12 and that when the arms 19 engage the third contact 21, as shown in the drawing, the relay 10 is caused to operate.

Energization of relay 10 causes its two armatures 60 and 61 to be attracted to engage their respective contacts. Armature 60 completes a circuit from ground, through the battery 27, the upper or actuating winding of relay 26, contact 90, armature 60, conductor 91, and contact 92 to ground at 93.

As the armature 60 continues its movement, contact 90 will be caused to engage contact 94. Engagement of contacts 90 and 94 completes a circuit from ground 93 through contact 92, conductor 91, armature 60, contacts 90 and 94, conductor 95, the upper winding of relay 96 and battery 97 to ground 98.

The relay 96 is thus energized to cause its armature 99 to engage contact 100 and thereby complete a circuit from ground 98 through battery 97, lower or holding winding of relay 96, armature 99, contact 100, conductor 101 and arm 16 to grounded segment 102. As the armature 99 completes its stroke the connection to ground 93, through contact 92 is broken. However, because of the above described connection a holding circuit is established for the relay 96.

The segment 102 corresponds to an arc which is not only greater than that bounded by the contacts 21, but is so positioned, with respect thereto, that the arm 16 engages segment 102 before arms 19 engage the extreme right hand contacts 21 and remains in contact with segment 102 after the arms 19 pass the extreme left hand contact 21. The corresponding armatures 60^a and 60^b and associated contacts of the relays 11 and 12 are adapted to be connected to the conductors 91 and 95, when either of these relays is energized, to control the energization of relay 96.

When the armature 60^a engages contact 90^a an energizing circuit for the relay 26^a will be completed through the conductor 91, contact 92 and ground 93.

In a similar manner engagement of armature 60^b with contact 90^b completes an energizing circuit for the relay 26^b through conductor 91, contact 92 and ground 93.

However, after a selection has been made, for example by the operation of relay 10, and relay 96 is locked up, as described above, the circuit through the actuating windings 26, 26^a and 26^b will be opened at contact 92. Consequently, even though at some later point in the travel of arms 19 either other relay, i. e. relay 11 or 12, is energized, it will be impossible to energize the actuating windings of either of the relays 26^a or 26^b.

Relay 96 and its associated contacts therefore serve to permit the connection of one of the radio channels to the receiver R while preventing the selection and connection of any of the other radio channels thereto during any one selecting period.

As noted above, energization of relay 10 causes the actuating winding of relay 26 to be energized. When this occurs the armatures 62, 63 and 64 will be attracted.

Armature 62 completes a circuit from ground through the relay 31 and battery 32, to ground. Relay 31 is thereby actuated to attract the switch contacts F_1 and armature 51. Closure of switch contacts F_1 extends the circuit E_1 to the receiver R. The function of armature 51 will be described later.

Operation of the armatures 63 and 64 completes a circuit through the lower or holding winding of the relay 26. This circuit extends from the battery 33, through the armature 64, the holding winding of 26, armature 63, conductor 34, armature 63^a, of relay 26^a, conductor 35 and armature 63^b of 26^b to ground.

In a preceding portion of this description it was stated that the contact arm 15

serves to control the operation of a step-by-step mechanism.

The circuit of the step-by-step mechanism extends from ground adjacent arm 15, through the slip ring 67, contact arm 15, relay 36, armature 68 of relay 29, and battery 69 to ground.

As the arm 15 engages the several contacts 70, current impulses are supplied to stepping relay 36 to actuate the stepping mechanism 37.

The stepping mechanism drives a shaft 38 which consists of two sections insulated from each other. Shaft 38 carries a contact arm 39 adapted to successively engage a series of contacts 40.

A slip ring 41 engaged by a contact 71 is also mounted upon the shaft 38. As noted above, when the relay 10 is energized its armature 61 is attracted to complete a circuit from ground through armature 61, conductor 28, relay 29 and battery 30 to ground.

Energization of the relay 29 causes its armature 68 to be attracted, whereby the circuit of the stepping magnet 36 is broken and the arm 39 comes to rest on the contact 40, which corresponds in position to that of arms 19 at which selection of a receiver is effected.

Assuming as before that conditions are such that the antenna A, and its associated receiver are selected at the third contact 21, then arm 39 will be in contact with the third contact 40 and simultaneously the armature 72 of relay 29 is attracted to complete the following circuit: from ground through this armature, conductor 42, contact 71, slip ring 41, contact arm 39, contact 40, conductor 43, the lower winding of relay 44 and battery 45 to ground.

Energization of relay 44 causes its armatures 73^b, 74^b and 75^b to engage associated contacts. Armatures 73^b and 74^b complete a circuit, through the upper or holding winding of relay 44. The holding circuit may be traced from ground through armature 73, armature 73^a, armature 73^b, front contact and upper or holding winding of relay 44, armature 74^b, armature 74^c and battery 46 to ground.

Simultaneously with the closure of the holding circuit, the armature 75^b completes a circuit to include resistance 47 in circuit 76 and to include resistances 48 and 49 therefrom.

Returning now to the relay 31, when this relay operates, in addition to closing the switch F_1, and additional armature 51 is actuated to engage a contact. Closure of armature 51 upon its associated contact completes a circuit from battery 52, through armature 51, conductor 53, and relay 54 (associated with the intermediate frequency amplifier of the selected receiver) to ground. Operation of the relay 54 associates the circuit 76, including resistance 47, with the selected receiver to permit its operation and control its gain.

The step-by-step control mechanism 37 is provided with a contact 77 adapted to be engaged by the arm 15. After the selecting period terminates, the arm 15 engages contact 77 to complete a circuit through magnet 78. This circuit may be traced from ground adjacent arm 15, through the contact and slip ring 67, arm 15, contact 77, release magnet 78, and battery 79 to ground. Energization of magnet 78 releases the stepping mechanism, permitting it to be automatically restored to normal position in which contact arm 39 is in engagement with the idle contact 80.

The resistances 47, 48 and 49 constitute sections of a gain control device, one or more of which may be connected in series in the intermediate frequency amplifiers to control the transmission level of the selected receiver. This gain device is provided to control the operation of the radio receivers, so that the output energy supplied by the receiver through the circuit E_1, E_2 and E_3 is maintained substantially constant and hence is independent of the amplitude of the incoming high frequency wave.

The radio channel including A, B, C, D, etc. having been selected and the gain of the receiver having been adjusted to a desired value, the incoming wave is amplified, and its frequency translated in the unit B. The intermediate frequency wave is supplied to and amplified in the unit C. The amplified intermediate frequency wave is detected to produce the signal currents, which are amplified in the unit D. The amplified signal currents are transmitted through the circuit E and switch F to the receiver R.

Assuming as before that the first receiver comprising the units A_1 to D_1 is selected, then that receiver continues to supply signal currents to the receiver R at least until the beginning of a new selecting period, i e., until the contact arms 19 again engage the extreme right hand contacts 21 of the gain control devices 4, 5 and 6.

If during a new selection period the amplitude of the wave incident upon the antenna A_1 is greater than that incident upon the antenna A_2 and A_3, the first receiver will continue to supply signal currents to the receiver R.

For the purpose of disclosing the operation of the system let it be assumed that, during the new selecting operation, the wave incident upon the antenna A_2 is of greater amplitude than those incident upon the antennæ A_1 and A_3, and that its amplitude is sufficiently large to cause relay 11 to operate when the contact arm 19 of control 5 engages the extreme right hand contact 21.

Energization of relay 11 initiates a cycle

of control operations similar to that described above with respect to the operation of relay 10.

The relay 26^a is energized to break the circuit of the holding winding of relay 26 at armatures 63^a and 64^a. Simultaneously there is established a holding circuit for the relay 26^a. This circuit may be traced from ground through battery 33, armature 64 and its back contact, armature 64^a and its front contact, holding winding of relay 26^a, armature 63^a and its front contact, and armature 63^b and its back contact to ground.

The release of relay 26 also causes the release of relay 31 and the opening of its associated contacts.

At the same time relay 31^a is energized to close the switch F_2 and connect circuit E_2 to the receiver R. In this case the radio receiver comprising the units B_2 to D_2, coupled to antenna A_2, is selected.

Operation of relay 11 will complete the circuit through conductor 28 to open the circuit of the stepping relay 36 and to complete the circuit controlled by the armature 72.

Selection having occurred at the first position of contact arm 18, the stepping mechanism will have advanced contact arm 39 from engagement with its idle contact 80 into contact with the extreme right hand contact 40.

Due to the operation of armature 72 a circuit will be established from ground through armature 72, contact 71, slip ring 41, conductor 81, winding of relay 82 and battery 83 to ground.

When relay 82 operates the holding circuit for relay 44 is broken by the armature 73 leaving its back contact. Armatures 73^b and 74^b associated with relay 44 are released and engage their back contacts and a circuit is completed through the upper or holding winding of relay 82 as follows: from ground, through armature 73 and its front contact, upper or holding winding of relay 82, armature 74, armature 74^a, armature 74^b, armature 74^c, and battery 46 to ground. Armature 84 of relay 82 engages an associated contact to connect resistances 47, 48 and 49 in series in the circuit 76.

Reverting now to the operation of relay 31^a. When this relay operates armature 51^a is attracted to complete a circuit from ground through battery 52^a, armature 51^a, conductor 53^a and relay 54^a to ground. Operation of the relay 54^a connects the circuit 76 including the series connected resistances 47, 48 and 49 with the circuit of the intermediate frequency stage C_2 to control the gain of the second radio receiver.

Obviously if the first or third receiver were selected at the first position of the selective mechanism the series resistances 47, 48 and 49 would have been associated with one of those radio receivers to control its gain.

Moreover, if selection of any one of the receivers occurs at the last position of the selective mechanism, i. e., with the arms 19 in engagement with the extreme left hand contacts 21 of the gain controls 4, 5 and 6, the control relay 85 will be energized to complete the selected receiver circuit and to short circuit the resistances 47, 48 and 49 so that none of the gain control resistances are associated with the selected radio receiver.

Since the amount of gain, utilized with the selected receiver is directly controlled by the position of arm 15 at the moment when selection is effected, it will be apparent that its magnitude is determined by the absolute value of the amplitude of the incoming wave.

When the gain control arms 19 are traversing the non-selecting portion of the cycle, i. e. the portion which does not include contacts 21, the input circuits of the rectifiers 7, 8 and 9 are open, consequently no actuating current can be supplied to the corresponding relays 10, 11 and 12.

The contact arm 16 having been rotated to a position where it is out of engagement with the grounded sector 102, the holding winding of relay 96 is open circuited, and its contact 92 completes the connection to ground 93 for the actuating windings of relays 26, 26^a and 26^b, whereby the circuits of these relays are prepared for the next selecting operation.

Owing to the length and position of the sector 102 with respect to the selecting arc, included by contacts 21, a ground connection is provided for the holding winding of relay 96 prior to the beginning of each selecting period and is maintained until after that period is completed.

Since the circuit of the holding windings for the relays 44, 82, etc. is dependent upon contacts associated with the armatures of those relays, operation of any relay of this group will serve to open the holding circuit of any of these relays which had been previously energized.

In the preceding description, it has been assumed that upon actuation of any of the relays 10, 11 or 12, its associated armature 61 will remain energized to complete the circuit of relay 29 during subsequent steps of the selecting period. However, it is possible that at some instant in the selecting period, after selection has been effected, the incoming wave may fade to such an extent that the relay 10, 11 or 12 which had been actuated may become deenergized and that the relay 29 will be deenergized to release its armature 68. This will cause the step-

ping mechanism to operate to reduce the resistance included in the gain control associated with the selected receiver. Such a condition would not detrimentally affect the operation of the apparatus. On the contrary it would be a distinct advantage since it would cause the operation of the stepping mechanism to increase the gain of the selected receiver and so compensate, in some measure, for the fading of the incoming wave.

What is claimed is:

1. The method of selecting from a group of waves having variable amplitudes one wave to the exclusion of the others, which comprises varying the effectiveness of said waves over a range, and selecting the wave which first reaches a predetermined value.

2. The method of selecting from a group of waves having variable amplitudes one wave to the exclusion of the others, which comprises periodically varying the effectiveness of said waves over a range, and selecting during each variation period the wave which first reaches a predetermined value.

3. The method of selecting one wave of a group of waves the amplitudes of which vary widely, which comprises separately receiving the waves, periodically varying the effectiveness of the waves over a range of values, selecting during each variation period the wave which first reaches a predetermined effective value, and preventing the selection of another wave during the variation period.

4. The method of selecting a wave from a group of waves the amplitudes of which widely vary which comprises separately amplifying the waves, periodically and simultaneously varying the effectiveness of the waves over a range of values, selecting during each variation period that wave which first reaches a predetermined effective value, and preventing the selection of another wave during that particular period.

5. The method of selecting from a group of waves having variable amplitudes, one wave to the exclusion of the others, which comprises varying the effectiveness of said waves over a range, and determining the effectiveness of the selected wave in accordance with its amplitude at the instant of selection.

6. The method of selecting a wave from a group of waves the amplitudes of which widely vary which comprises separately amplifying the waves, periodically and simultaneously varying the effectivenes of the waves over a range of values, selecting during each variation period that wave which first reaches a predetermined effective value, and determining the effectiveness of the selected wave in accordance with its amplitude at the instant of selection.

7. The method of selecting a wave from a group of waves the amplitudes of which widely vary which comprises separately amplifying the waves, periodically and simultaneously varying the effectiveness of the waves over a range of values, selecting during each variation period that wave which first reaches a predetermined effective value, and varying the effectiveness of the selected wave should its amplitude change radically between the instant of selection and the termination of the variation period.

8. An apparatus for selecting one wave from a group of waves having variable amplitudes, comprising means for varying the effectiveness of said waves over a range, and means for selecting the wave which first reaches a predetermined value.

9. In combination, a plurality of sources of wave energy of varying amplitudes, a device associated with each of said sources, means for simultaneously varying the gain of said devices over a range, and associated with each device means to respond to that wave which first reaches a predetermined value as the gain is varied.

10. In combination, a plurality of carrier wave receivers so arranged that the reception conditions are different at each, a variable gain device associated with each receiver, means for simultaneously and periodically varying the gain of said devices over a range and associated with each device means to select during each period of variation that receiver which first supplies energy of predetermined value.

11. In combination, a plurality of carrier wave receivers arranged so that reception conditions at each are different, means for controlling the effectiveness of the energy supplied by each receiver, means for simultaneously varying said control means over a range of values, and means for selecting that receiver which first supplies energy of predetermined value.

12. In combination, a plurality of carrier wave receivers arranged so that reception conditions are different at each, a variable gain control device associated with each receiver, means for simultaneously varying over a range the gain of said devices, and, associated with each device, means for selecting during each variation period the receiver which first supplies energy of predetermined value and for preventing the operation of the selecting means associated with the other receivers.

13. An apparatus for selecting one wave from a group of waves having variable amplitudes, comprising means for varying the effectiveness of said waves over a range, and means for determining the effectiveness of the selected wave in accordance with its amplitude.

14. In combination, a plurality of carrier wave receivers arranged so that reception

conditions at each are different, means for controlling the effectiveness of the energy supplied by each receiver, means for simultaneously varying said control means over a range of values, and means for determing the effectiveness of the energy supplied by the selected receiver in accordance with the value of the wave supplied thereto.

15. An apparatus for selecting one wave from a group of waves having variable amplitudes, comprising means for varying the effectiveness of said waves over a range, and means for determining the effectiveness of the selected wave in accordance with its amplitude at the instant of selection and for varying its effectiveness should its amplitude change radically subsequent to selection.

16. An anti-fading means for a radio receiving system, including a plurality of radio receivers at which reception conditions are different and an audio frequency channel, comprising means for simultaneously varying over a range of values the output energy supplied by said receivers, and means controlled by the energy supplied by the respective receivers to select the receiver which first supplies energy of a predetermined value and to connect the selected receiver to the audio channel.

17. An anti-fading means for a radio receiving system, including a plurality of radio receivers at which fading effects vary differently from time to time, and an audio frequency channel, comprising means for simultaneously and periodically varying over a range of values the output energy supplied by said receivers, and means controlled by the energy supplied by the respective receivers during each period of variation for selecting the receiver which first supplies energy of a predetermined value and for connecting the selected receiver to said audio channel.

18. A radio receiving system comprising a plurality of radio receivers at each of which reception conditions are different, an audio frequency channel, a gain control device associated with each receiver, means for simultaneously and periodically varying said gain control devices, and, associated with each device, means for selecting during each period of variation the receiver which first supplies energy of a predetermined value and for connecting it to said audio channel.

19. An anti-fading means for a radio receiving system including a plurality of radio receivers at which reception conditions are different and an audio frequency channel, comprising means for simultaneously varying over a range of values the output energy supplied by said receivers, and means controlled by the energy supplied by the respective receivers to select the receiver which first supplies energy of a predetermined value and to connect the selected receiver to the audio channel, and to control the energy supplied to said audio channel in accordance with the amplitude of the energy impressed upon the selected receiver.

20. An anti-fading means for a radio receiving system, including a plurality of radio receivers at which fading effects vary differently from time to time, and an audio frequency channel, comprising means for simultaneously and periodically varying over a range of values the output energy supplied by said receivers, means controlled by the energy supplied by the respective receivers during each period of variation for selecting the receiver which first supplies energy of a predetermined value, means for connecting the selected receiver to said audio channel, and mean for maintaining substantially constant the energy supplied to said audio frequency channel irrespective of the amplitude of the energy supplied to the selected receiver.

In witness whereof, I hereunto subscribe my name this 21st day of March, 1929.

LEON J. SIVIAN.