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TRANSMISSION REGULATION

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Fig. 1.

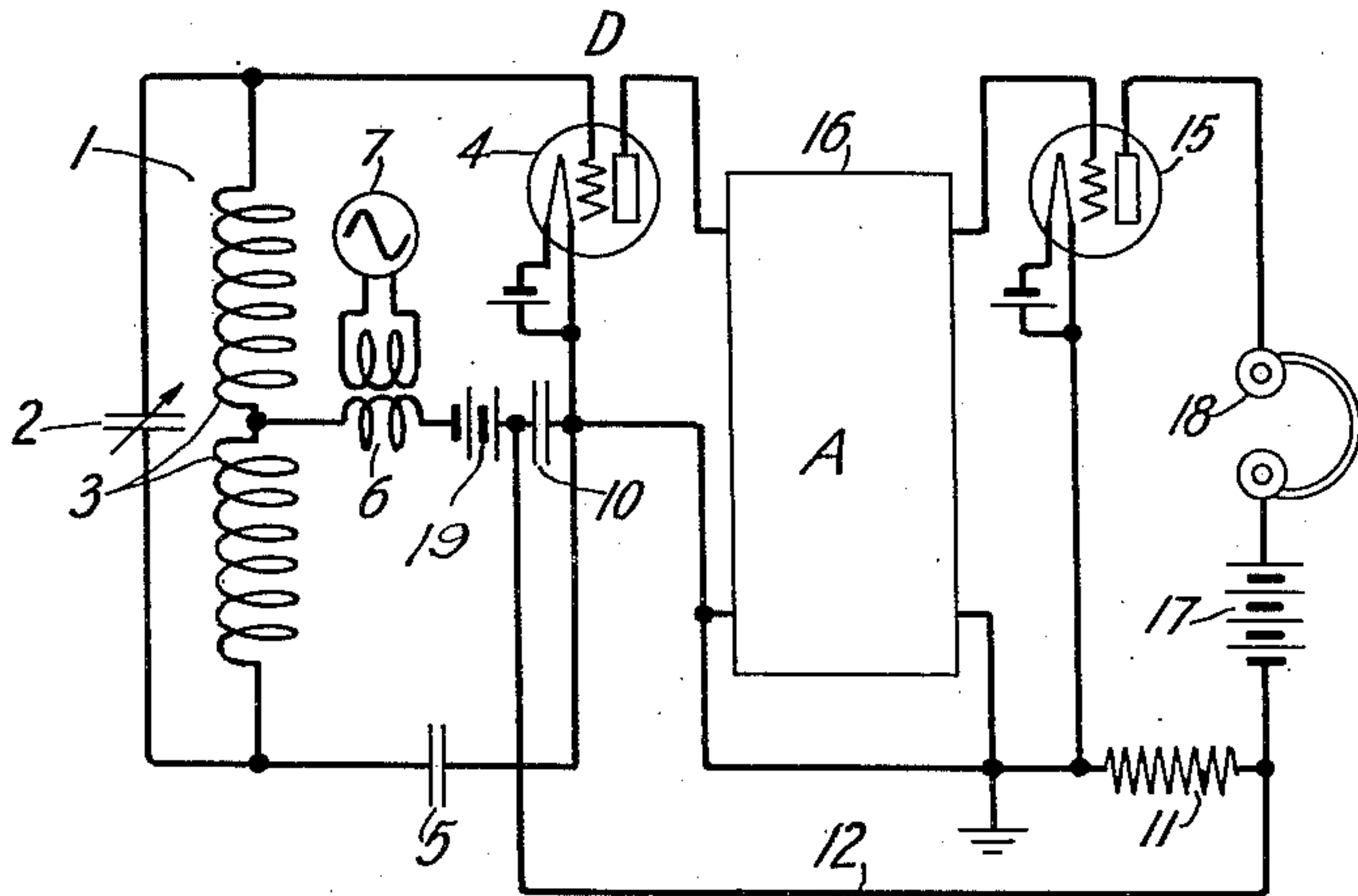
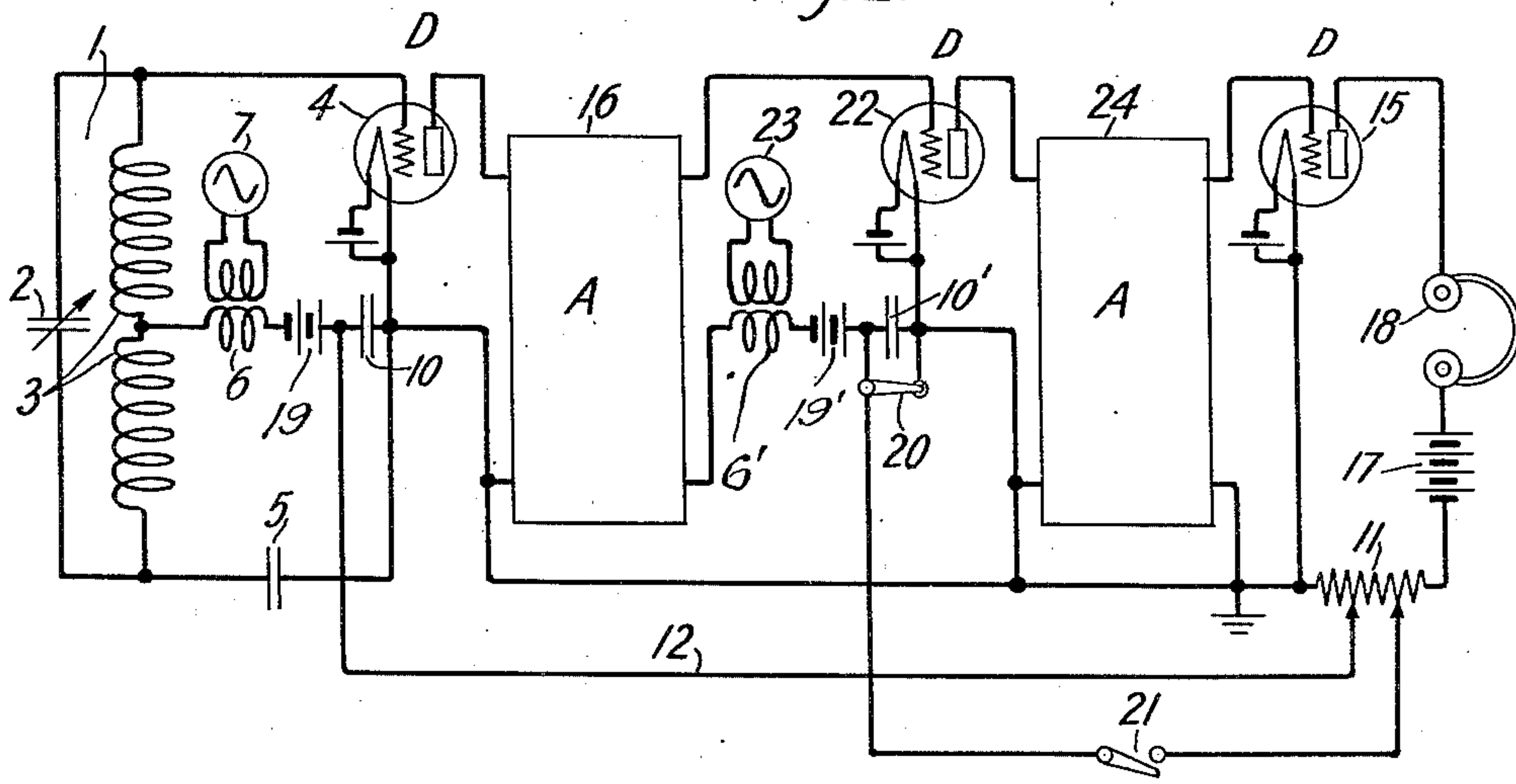


Fig. 2.



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TRANSMISSION REGULATION

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This invention relates to wave transmission, and particularly to short wave radio signaling.

An object of the invention is automatic volume control of transmission, and especially reduction of fading effects in short wave radio telephony.

In a successive detection receiver embodying the invention, D. C. voltage drop across a resistance in the plate circuit of the last detector variably biases a grid of the first detector, to reduce fluctuations in the output of the last detector.

Fig. 1 of the drawing shows a double detection receiver; and Fig. 2 shows a triple detection receiver embodying the invention.

In Fig. 1, a tuned circuit 1, comprising a variable tuning condenser 2 and a loop antenna represented as an inductance coil 3, receives radio signaling waves, as for example, speech signal modulated carrier waves, and delivers them from the half of the loop represented by the upper half of coil 3 to the input circuit of a high frequency detector 4, shown as an electric space discharge detector. The end of the loop represented by the lower end of coil 3 is connected to the grounded filament of the detector through a condenser 5 which has a capacity equal to the effective input capacity of the detector, and the center of the loop is connected to the grounded detector filament through a condenser 10 of negligible reactance for frequencies of the order of the resonant frequency of tuned circuit 1. The loop is preferably rotatable as usual for obtaining directional selectivity, and the directional selectivity is increased by the connecting of the center of the loop inductance to earth and the use of the condenser 5 for preventing unbalance of the capacities connected to the loop, with respect to ground. The detector A. C. input circuit includes a coil 6 coupled to a beating oscillator 7, preferably of the electric space discharge type, in series with a grid biasing battery 19 and the condenser 10. The D. C. connection between the filament and the grid of the detector 4 extends from ground through a resistance 11, conductor 12, the grid biasing battery 19 for the detector, coil 6, and upper half of coil

3 to the detector grid. The function of resistance 11 is brought out hereinafter.

The output circuit of the detector 4 is connected to the input circuit of a low frequency detector 15 through an intermediate frequency amplifier 16. The output circuit of the detector 15 includes a telephone receiver 18, or other signal indicating means, in series with the resistance 11 and a battery 17 for supplying space current to detector 15.

By the action of detector 4 and beating oscillator 7 the frequency of the waves received by loop 3, which may be, for example, of the order of 10^7 cycles per second is changed to a lower frequency, as for example, a frequency of the order of 300,000 cycles. These lower frequency waves, after selective amplification in an intermediate frequency amplifier 16, are delivered to detector 15, which operates to reproduce the speech or other signal current of the signal modulated wave received by loop 3, to render the signal audible in telephone 18. The frequency range of the intermediate frequency amplifier may extend, for example, from 295,000 to 305,000 cycles per second.

The balancing condenser 5 prevents the incoming wave from developing across the coil 6 a voltage which would be induced in the circuit of vacuum tube oscillator 7. If a voltage were so induced in the oscillator, there would be danger that the oscillator would function as a self-oscillating detector developing a difference frequency which would be transmitted through the grid-plate capacity of tube 4 and through intermediate frequency amplifier 16.

Preferably the system is originally adjusted so that with no incoming signal the D. C. grid bias of detector 4 is such that the point of operation on the grid voltage plate current characteristic is the point where the curvature is the greatest, and furthermore so that the beating oscillator peak voltage is at least equal to the additional bias necessary to cause plate current cut off. Then when signals are received, an additional negative bias is applied to the detector grid due to the drop across resistance 11, resulting in two simultaneous effects, one a shift downwardly to

an operating point on the characteristic of detector 4 at which the curvature is less, and the other, an effective reduction of the beating oscillator input, due to an increased portion of the wave being below plate current cut off.

Then as the signaling waves incoming to the loop decrease in strength, due, for example, to fading, the D. C. plate current of detector 15 decreases and, hence, the IR drop across resistance 11 decreases, causing reduction of the negative grid bias of detector 4 and consequent shift upwardly to an operating point on the characteristic of detector 4 at which the curvature of the characteristic is greater, and also causing an increase in the effective beating oscillator input. This tends to increase the output of the high frequency detector and, therefore, counteracts the decrease in the strength of the signaling waves received by loop 3.

When the strength of the signaling waves received by the loop increases, the reverse action occurs, tending to cause a decrease in the output of the receiver.

The system thus compensates for carrier fading by automatically readjusting the receiver gain. The use of such compensation enables satisfactory reception of speech in cases in which the reception would otherwise be unsatisfactory, due to violent fading.

In the theoretical limiting case in which a change in the plate current of the second detector is just sufficient to produce in resistance 11 sufficient IR drop to cut off the plate current of the first detector, the second detector voltage input, which that second detector plate current change represents, is the greatest voltage input to which a signal of any magnitude whatever can subject the second detector, because a greater voltage input to the second detector cuts off the plate current of the first detector and thereby completely destroys the signal.

The system has a very large volume control range per tube on which the grid bias variation is effected. With a system such as shown in Fig. 1, in which the resistance 11 was 20,000 ohms and the capacity 10 was 1 mf., tests showed that an increase in signal voltage input of one million-fold only doubled the input voltage of the low frequency detector.

When the plate current of the high frequency detector approaches cutoff by the operation of the fading prevention means, the signal cannot appear in appreciable magnitude even due to passage through inter-electrode tube capacities, since detector 4 is then very inefficient in converting the incoming frequency to that frequency required by the intermediate frequency amplifier 16.

Since the tube on which the grid bias change is effected is a detector tube, the change of bias does not produce danger of

singing or characteristic resonant frequency shift.

Moreover, when control is effected by varying the grid bias of amplifiers, fading causes the tube noise to bob up and down, even though the signal may be steady; whereas in the system of Fig. 1, existing tube noise is steady as well as the signal, which experience shows to be less disturbing.

In regard to the speed of operation of the control, when resistance 11 is 20,000 ohms and capacity 10 is 1 mf. the time constant RC of the control is $20,000 \times 10^{-6} = 0.02 = \frac{1}{50}$ second. This is sufficiently fast for practically all cases of ordinary fading. The capacity 10 should be sufficiently large to offer a low impedance path to ground for the high frequencies and particularly to prevent intermediate frequency feed-back and singing.

In order to obtain a large range of volume control, a receiver should have available large excess amplification. For example, if a signal amplitude fades, say, from its maximum to one-fiftieth of its maximum, the receiver should have available more than 50 times in excess amplification. The intermediate frequency voltage gain of the system described above may be, for example, 120,000 times at 300 kilocycles, or may be the largest amplification from which the tube noise can be tolerated.

In the system described above, the wide frequency separation between the A. C. output from tube 15 and the A. C. input to tube 4 tends to prevent singing due to the feed-back from resistance 11 to the input circuit of tube 4.

Still further insurance against singing in a fading control system of this general type can be obtained by employing more than two stages of detection, and effecting the fading control by varying the bias of the grid of the first detector in response to the volume changes in the output of the last detector. The frequency of the input wave applied to the last detector will then be widely different from the frequency of the output wave of the first detector, and the danger of singing will be reduced to a greater degree than in a double detection system.

Fig. 2 illustrates, by way of example, a triple detection system, when the switch 20 therein is closed and the switch 21 is open. The system is then like the system of Fig. 1, except for the insertion between the first intermediate frequency amplifier 16 and the low frequency detector 15, of the detector 22 and its beating oscillator 23 and the second frequency selective intermediate frequency amplifier 24. Since danger of intermediate frequency singing is considerably reduced, compared with a double detection system, the capacity of condenser 10 may be greatly reduced, with consequent reduction in the time

constant of the system and with resulting improvement in the operating speed of the fading control.

Where it is desired to reduce the range of variation which the signals produce in the input to the third detector, the bias of the grids of both the first and the second detector may be caused to vary, simultaneously, in response to volume changes in the output of the third detector. This control may be caused to take place by opening switch 20 and closing switch 21.

The term "low frequency" as used herein includes the limiting frequency zero, that is, D. C.

What is claimed is:

1. A receiver for speech modulated high frequency carrier waves, comprising a frequency changing unit including an electric space discharge modulating device, a source of voltage of frequency different from said high frequency and connected to said electric space discharge device for beating down said higher frequency, means for selectively amplifying the wave of changed frequency to the exclusion of said waves of high frequency, and means for detecting said selected wave to produce speech currents, said last mentioned means comprising a connection to the first detector to apply thereto a voltage of such magnitude and direction as to tend to control the volume fluctuations in said speech currents due to fluctuations in the strength of said high frequency waves.

2. A receiver for high frequency waves comprising a detector for changing the frequency of the received wave, means for amplifying the wave of changed frequency, a second frequency changing detector, a second means for amplifying the wave of reduced frequency delivered by said second detector, and means for detecting the amplified wave from said second amplifying means, said last mentioned means comprising a vacuum tube device with a connection to the first detector to apply thereto a potential of such magnitude and direction as to tend to maintain constant the output of the receiver.

3. A receiver for high frequency waves comprising a detector for changing the frequency of the received wave, means for amplifying the wave of changed frequency, a second frequency changing detector, a second amplifying means for amplifying the wave of reduced frequency delivery by said second detector, and means for detecting the amplified wave from said second amplifying means, said last mentioned means comprising a vacuum tube device with a connection to the first detector and a connection to the second detector to apply to said detectors potentials of such magnitude and direction as to tend to maintain constant the output of the receiver.

4. A receiver for high frequency waves comprising a plurality of frequency chang-

ing detectors, an amplifier, for each of the waves produced by said frequency changing detectors, means for detecting the lowest changed frequency wave to produce signal currents, and means energized by said signal currents to apply to the first detector, a variable potential of such magnitude and direction as to tend to maintain the signal volume constant.

5. A system for converting alternating current into uni-directional current comprising space discharge devices including a plurality of rectifiers for supplying current to a load circuit, impedance elements and sources of biasing potential individual to said space discharge devices, and coupling means interconnecting said devices, said impedance elements and coupling means being current responsive to vary the conversion efficiencies of said rectifiers in accordance with fluctuations in the alternating current.

6. A wave detecting system controlled in respect to detection efficiency by means of and in accordance with selected characteristics of the waves to be detected, comprising a plurality of space discharge devices, an input circuit for supplying waves to said devices, individual means for biasing each of said devices, an output circuit for transmitting detected currents to a load circuit, and means for utilizing a portion of said detected currents for varying the biasing potential applied to a plurality of said devices.

7. A receiver of high frequency energy comprising means for reducing the frequency of the received energy, means for producing a uni-directional current from the reduced frequency energy, and means controlled by said uni-directional current for applying a variable potential to said frequency reducing means to control its operation.

8. A radio receiver comprising means for changing the frequency of the received wave, means for producing a uni-directional current from the wave of changed frequency, and means supplied with said uni-directional current for controlling the operation of said frequency changing means in accordance with a variable characteristic of said received wave.

9. A radio receiver comprising means for changing the frequency of the received wave, means for producing a uni-directional current from the wave of changed frequency, and means supplied with said uni-directional current to control the operation of said frequency changing means to maintain constant the current output of said receiver in spite of variations in said received wave.

10. In a system for receiving waves of given frequency including a space discharge device, means to apply waves of said given frequency to the control electrode of said device, means for changing the frequency of the waves in the output circuit of said system to

- a different frequency level, means to derive from said waves of changed frequency a negative voltage, and connections for applying said negative voltage to the control electrode of said discharge device to vary the gain of said system, said system including means preventing the application to said control electrode of wave components having the same frequency level as the received wave.
11. In a wave receiving system comprising a plurality of space discharge devices, means to impress waves of the received frequency on certain of said devices, an amplification control comprising means for impressing upon the control electrode of certain of said devices a potential, which becomes more negative with increasing output and less negative with decreasing output, whereby said output is maintained substantially constant with varying input and means to avoid singing in said system, due to feed back, comprising frequency changing means producing a wave from which said negative potential is exclusively derived and which differs in frequency by a large amount from the received frequency.

In witness whereof, I hereunto subscribe my name, this 23rd day of December, A. D., 1926.

EDMOND BRUCE.