

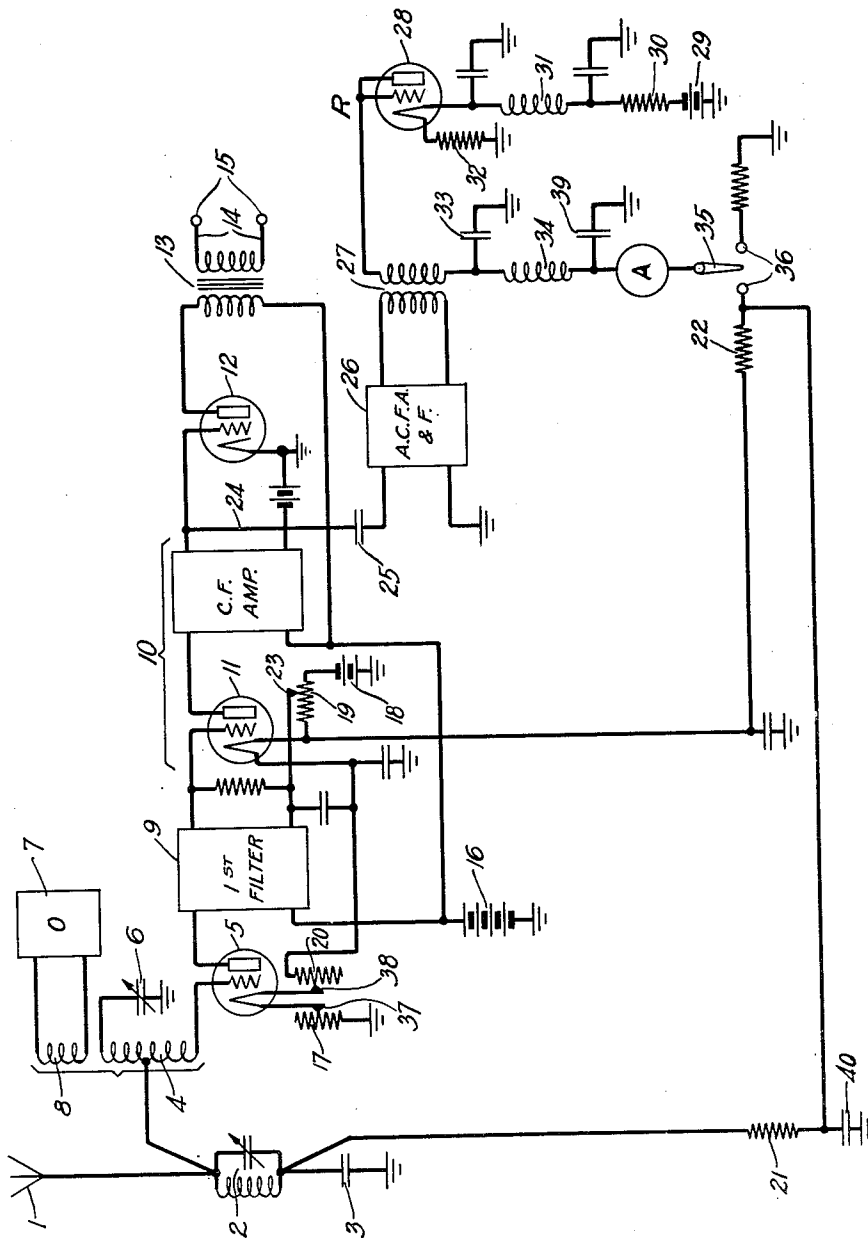
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J. C. GABRIEL ET AL

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TRANSMISSION REGULATION

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TRANSMISSION REGULATION

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This invention relates to radio receiving systems and more particularly to means for maintaining at a constant level the output energy supplied to a load circuit.

Numerous gain control devices have been proposed which utilize different components of the incoming wave to effect the desired control. One such type is that disclosed in Patent 1,511,015 to Affel, October 7, 1924, in which the unmodulated carrier component is utilized to effect the desired control. Another type is disclosed in an application of E. Bruce, Serial No. 158,169, filed December 31, 1926, Patent 1,778,750, October 21 1930, in which the signal or audio frequency component or a component of changed frequency, derived from the received wave, may be used to effect the control function.

The present invention relates to a system which embodies certain features of the above-mentioned patent and application in combination with added features for improving and simplifying the operation of the gain control mechanism.

An object of this invention is to effect gain control which, while extremely efficient and having a small time lag, requires a minimum of manual adjustment to regulate its operation.

Another object is to regulate the operation of the gain control mechanism by a single adjustment, which fixes the relative potentials applied to a plurality of devices included in the receiver.

A feature of the invention relates to the provision, in a circuit including a space discharge tube the grid of which is biased by a potential derived from a point of fixed potential in the filament heating circuit, of means whereby the potential difference between the grid and filament may be changed without changing the potential of the fixed point.

The above objects are accomplished in one embodiment of the invention, comprising a successive detection receiving system, by utilizing a portion of the changed frequency component derived from the received wave.

The selected portion of the changed frequency energy is amplified, preferably in one

or more stages each including a space discharge device, and rectified. The amplifiers and rectifier are included in a path separate from that traversed by the detected signal currents.

The rectified current is supplied to a high resistance. Since the rectified current varies in accordance with variations in the amplitude of the changed frequency and hence the amplitude of the incoming wave, from which it is derived, a variable voltage drop will be produced across the resistance. This variable voltage is applied to the high frequency detector to control its gain, in a manner inverse to fluctuations in the incoming wave, whereby these fluctuations are compensated.

In addition to the variable gain control potential, the various space discharge devices or tubes, which operate as amplifiers and rectifiers, are supplied with steady biasing potentials derived from resistance elements included in the circuits through which heating current is supplied to the filaments of the discharge devices.

In order that the steady biasing potentials and the variable potentials, used to control the gain of the receiver, may always be controlled to have the same relative values in spite of changes in the operating characteristic of the receiver or changes in the circuits thereof, for example, when a space discharge tube is changed, a pair of simultaneously adjustable resistances are included in the filament heating circuit of the filament of one of the discharge tubes.

The resistances function to permit the potential difference between the grid and filament of the tube, with which they are associated, to be varied without affecting the potential of the point on the filament heating circuit whence are derived potentials applied to the electrodes of other tubes in the system and without changing the value of the current flowing through the portion of the filament heating circuit in which they are included.

The principles of the invention, together with its organization and method of operation, will be clear from the following description.

tion read in conjunction with the attached drawing:

The single figure illustrates a radio receiver, operating on the basis of successive detection, which embodies the invention.

While the invention may be applied to apparatus used for receiving radio telegraph or telephone signals, it will hereinafter be described by way of example as applied to a receiver for radio telephony.

In the drawing there is shown an antenna 1 connected through a tuned circuit 2 and condenser 3 to ground.

The circuit 2 is tuned to the frequency of the wave to be received. The condenser 3 serves as a low impedance path to ground for the high frequency energy and to prevent the flow of direct or low frequency current to ground.

High frequency energy, produced in the tuned circuit 2 by the wave incident upon the antenna 1, is supplied to the coil or autotransformer 4.

The connection from the antenna circuit is made at an intermediate point of the coil 4, which has one terminal connected to the grid of modulator 5 and its other terminal connected through an adjustable condenser 6 to ground.

Oscillations from the source 7, which may be of any type, for example, a vacuum tube oscillator, are supplied through a coupling between the coils 8 and 4 to the grid of the modulator 5.

The method of connecting the antenna to the tube 5 is similar to that disclosed in application, Serial No. 48,988, filed August 8, 1925 by E. Bruce, Patent 1,710,254, April 23, 1929, and it is used for the purpose therein set forth. Briefly its purpose is to permit the source of local oscillations to be conjugately coupled with respect to the antenna. This serves two purposes, first, it prevents radiation of the locally supplied oscillations, and second, it permits the tuning of the circuit 2 to be adjusted without causing variations in the amount of energy supplied by the local source to the modulator.

The incoming wave and the locally supplied oscillations are combined in the device 5 to produce a changed frequency wave. This wave is selected by the filter 9 and amplified by an amplifier 10 comprising any number of stages.

One stage of the changed frequency amplifier is shown in detail at 11, as a distortionless amplifier comprising a space discharge device. However, any other type of distortionless amplifier may be used.

The changed frequency wave is applied to the input electrodes of the detector 12 in which it is detected to produce the speech currents which are supplied through a transformer or repeating coil 13 to a load circuit 14.

Obviously the load circuit may be local to the receiving station or may constitute a connection to a remote station. For local operation, a telephone receiver or loud speaker will be connected to the terminals 15. For remote operation, the terminals 15 may be connected over a telephone line to a central office through which connection may be extended to any subscriber of the system.

Space current is supplied to the discharge devices 5, 11 and 12 from the direct current source 16.

For tube 5 the space current path extends from the positive terminal of source 16 through a conductive path within the filter 9, anode of tube 5 to its cathode, the left hand resistance 17 and via ground to the negative terminal of source 16.

The space current circuit for tube 11 extends from the positive terminal of source 16, a conductive path in the diagrammatically shown portion of the changed frequency amplifier, anode of 11 to its cathode, resistance 20, cathode of 5, resistance 17 and via ground to the negative terminal of battery 16.

The tube 12 is supplied with space current over the circuit extending from the positive terminal of source 16, primary winding of transformer 13, anode of 12, its cathode and through ground to the negative terminal of source 16.

As shown in the drawing, heating current is supplied to the filaments of tubes 11 and 5, connected in series, from the negative terminal of source 18, resistance 19, the filament of tube 11, a portion of resistance 20, filament of tube 5, a portion of resistance 17 and through ground to the positive terminal of source 18.

The grid of tube 5 is connected to its filament over the following direct current path. From the grid of tube 5 through the lower half of coil 4, the inductance of the tuned circuit 2, a resistance 21, resistance 22, the filament of tube 11, a portion of resistance 20 to the right hand or negative terminal of the filament of tube 5.

The grid is therefore negatively biased by the voltage drop caused by the flow of filament heating current through the series circuit including the filament of tube 11 and the portion of resistance 20 associated with the filament of tube 5.

The grid of tube 11 is negatively biased by the voltage drop due to the flow of filament heating current through that portion of the resistance 19 between the contact 23 and its terminal connected to the filament lead.

The output side of the changed frequency amplifier 10 is connected by a lead 24 including a blocking condenser 25 to a plural stage auxiliary changed frequency amplifier 26. A portion of the changed frequency energy is supplied through the lead 24, including the

condenser 25, to the auxiliary unit 26. After being amplified in unit 26, the changed frequency current is supplied by a transformer 27 to a rectifier R. The rectifier is herein shown, by way of example, as including a three electrode space discharge device 28 having its grid and plate electrodes directly connected to constitute, in effect, a two electrode device.

Heating current is supplied to the filament of the rectifying tube 28 from a source 29 over the following circuit. From the negative terminal of source 29 through a resistance 30, ripple suppressing filter 31, the filament, resistance 32 and ground to the positive terminal of source 29.

The circuit through which the auxiliary changed frequency current is applied to the rectifier 28 extends from its grid and plate, through secondary winding of transformer 27, condenser 33 to ground and thence through resistance 32 to its filament and across the space path within 28 to its grid and plate.

The receiving system is so designed that, when the wave incident upon the antenna has an amplitude of definitely chosen value, speech current of the minimum amplitude necessary for satisfactory commercial operation is supplied to the apparatus or line connected to the terminals 15 and the grids of the various tubes have impressed thereon the steady potentials referred to above.

When the system is in operative condition, switch 35 is thrown to the left to engage contact 36.

Provided the amplitude of the incident wave is greater than is necessary to produce output speech currents of an amplitude equivalent to the minimum commercially satisfactory value, changed frequency current is supplied to the rectifier R.

The rectified current produced by rectifier R flows over the following circuit. From the grid and plate electrodes of tube 28, through the secondary winding of transformer 27, ripple suppression filter 34, switch 35, contact 36, resistance 22, filament of tube 11, resistance 20, filament of tube 5, resistance 17 and through ground to resistance 32, filament of tube 28 and across its space path to its grid and anode.

The drop of voltage across the filaments of tubes 11 and 5 and the included portion of resistance 20 and resistance 22, due to the flow of the unidirectional component of the rectified current therethrough, will be impressed upon the grid of modulator 5, to supplement the biasing potential applied hereto due to flow of heating current.

By virtue of the supplementary biasing potential, the overall gain of the system is controlled to transmit a desired amplitude of speech current to the apparatus or line connected to terminals 15.

Should the amplitude of the incident wave

increase or decrease, due to fading effects, the amplitude of the rectified current and the voltage drops across the filaments of tubes 11 and 5 and the resistances 20 and 22 will vary correspondingly. The voltage applied to the grid of modulator 5 will, therefore, increase or decrease to decrease or increase the overall gain of the system and thereby maintain constant the amplitude of the speech current supplied to the apparatus or line connected to terminals 15.

As in the above mentioned Bruce application, Patent 1,778,750, the speed of operation of the control is determined by the resistance (R) and the capacity (C) in shunt to R. In the present system, R is the resistance 22 and is of 100,000 ohms. The capacity (C) in shunt to 22, is the combined capacities of condensers 3, 40, 39 and 33 which equals .4 mf. The time constant (RC) is therefore

$$100,000 \times 10^{-6} \times \frac{.4}{10} = .04 \text{ second,}$$

which is satisfactory for one operating condition. The value of the capacity of combined condensers 3, 40, 33 and 39 may be materially reduced in practice and hence the speed of operation may be increased.

However, if the incident wave fades to such an extent that the amplitude of the speech current is below the value necessary for satisfactory commercial operation, the auxiliary amplifier cuts off to prevent the transmission of changed frequency current to the rectifier tube 28. Hence no gain control potential is applied to the grid of the modulator 5.

The grid and plate of tube 28 are connected, by a direct current path, to the left hand terminal of resistance 19 and, therefore, have applied to them a negative potential determined by the source 18 and resistance 19. This path includes the resistance 22.

Any direct current flow through the resistance 22 would change the biasing potentials applied to the grids of tubes 5 and 11 and thereby interfere with the proper operation of the gain control mechanism.

For example, if the grid and plate of tube 28 are at a positive potential with respect to its filament, direct current will flow through the resistance 22 and thereby increase the biasing potential applied to the grid of tube 5. This would decrease the overall gain of the system and thereby reduce the speech current supplied to the apparatus or line connected to terminals 15, to a value which would be unsatisfactory for commercial operation.

To prevent the flow of direct current through the resistance 22, under the conditions stated above, the heating circuit of the filament of tube 28 is provided with resistance units 30 and 32 of such value that one

terminal of the filament of tube 28 has applied thereto a negative potential substantially the same or slightly less than that applied to its grid and plate. Since the tube 28 is unilaterally conductive and current can only flow across its space path when the grid and plate are positive with respect to its filament, no current will flow through its output path, including resistance 22, until changed frequency current, adapted to render the grid and plate positive with respect to the filament, is supplied to the tube.

However, by maintaining equal potentials upon the respective electrodes of tube 28, i. e. grid, plate and filament, rectified current will flow through resistance 22 when the tube is supplied with changed frequency current of the proper polarity to render the grid and plate positive with respect to the filament.

During the operation of the system it may be necessary or desirable to change the steady potential applied to the grid of the modulating tube 5. To effect this function, without distributing the potential relations with respect to the rectifier tube 28, the filament of tube 5 is provided with two simultaneously adjustable contacts 37 and 38, which respectively engage the resistances 17 and 20.

As the contacts 37 and 38 are shifted, the amount of resistance 20, connected between its filament and the negative lead of the filament of tube 11 is varied. Consequently the potential difference between the filament of tube 5 and its grid is changed. At the same time, the amount of resistance 17 included in the filament heating current is changed by an equal amount to maintain the heating current constant.

The method of control, for the biasing potential applied to the grid of tube 5, possesses the advantage that this potential may be varied by a single adjustment to meet varying conditions of operation, without changing the total current flowing through the heating current circuit of tubes 11 and 5 and without varying the potential applied to the grid and plate of rectifying tube 28.

While one embodiment of the invention has been disclosed and certain specific details have been described, it is to be understood that this invention is not limited thereto but only by the scope of the attached claims.

What is claimed is:

1. In combination a space discharge device including a hot electrode and at least one cold electrode, a circuit through which heating current is supplied to said hot electrode, means for deriving from said heating circuit a normally fixed potential and applying it to said cold electrode, means in the heating circuit for changing the potential difference between said hot and cold electrodes while maintaining constant said nor-

mally fixed potential and means actuated by the output current of said space discharge device for varying said normally fixed potential.

2. A system comprising space discharge devices each including a hot electrode and at least one cold electrode, at least one of said cold electrodes being a grid, a circuit through which heating current is supplied to said hot electrodes, means for deriving from said heating circuit a fixed potential and applying it to the cold electrodes of a plurality of said discharge devices, and means in the heating circuit for changing the potential difference between the hot and cold electrodes of at least two of said plurality of discharge devices while maintaining constant said fixed potential, said means operating to change the potential of said grid and the potential of the hot electrode of another of said space discharge devices.

3. A system comprising space discharge devices each including a hot and at least one cold electrode, a circuit through which heating current is supplied to said hot electrodes, means for deriving from said heating circuit a fixed potential and applying it to cold electrodes of a plurality of said discharge devices, means for maintaining the hot electrode of one of said plurality of devices at substantially the fixed potential, and means in the heating circuit for changing the potential difference between the hot and cold electrodes of at least one other of said plurality of devices while maintaining constant the fixed potential.

4. A system comprising space discharge devices each including a hot and at least one cold electrode, means for connecting certain of said devices in cascade, a series circuit through which heating current is supplied to the hot electrodes of said cascade connected devices, means for deriving from said heating circuit a fixed potential and applying it to cold electrodes of one of said certain devices and at least one other device, means for controlling said other device for applying a varying potential to the electrode of said certain device to which the fixed potential is applied, and means in the heating circuit for changing the potential difference between the hot and cold electrodes of said certain device while maintaining constant said fixed potential.

5. A receiver for signal modulated high frequency carrier waves comprising a space discharge modulating device including a cathode and grid, a circuit through which heating current is applied to said cathode, means for deriving from said heating circuit a fixed potential and applying it to said grid, a source of oscillations differing in frequency from the wave to be received and connected to said modulator for changing

the frequency of said received wave, means
for selectively amplifying the wave of
changed frequency, means for detecting said
selected wave to produce the signal current,
5 means for rectifying a portion of said
changed frequency wave, means actuated by
said rectified current to control the gain of
said receiver, and means in said heating cir-
cuit for changing the potential difference
10 between said cathode and said grid while
maintaining constant said fixed potential.

In witness whereof, we hereunto subscribe
our names this 9th day of March, 1929.

JOHN C. GABRIEL.

FRANK A. HUBBARD.

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