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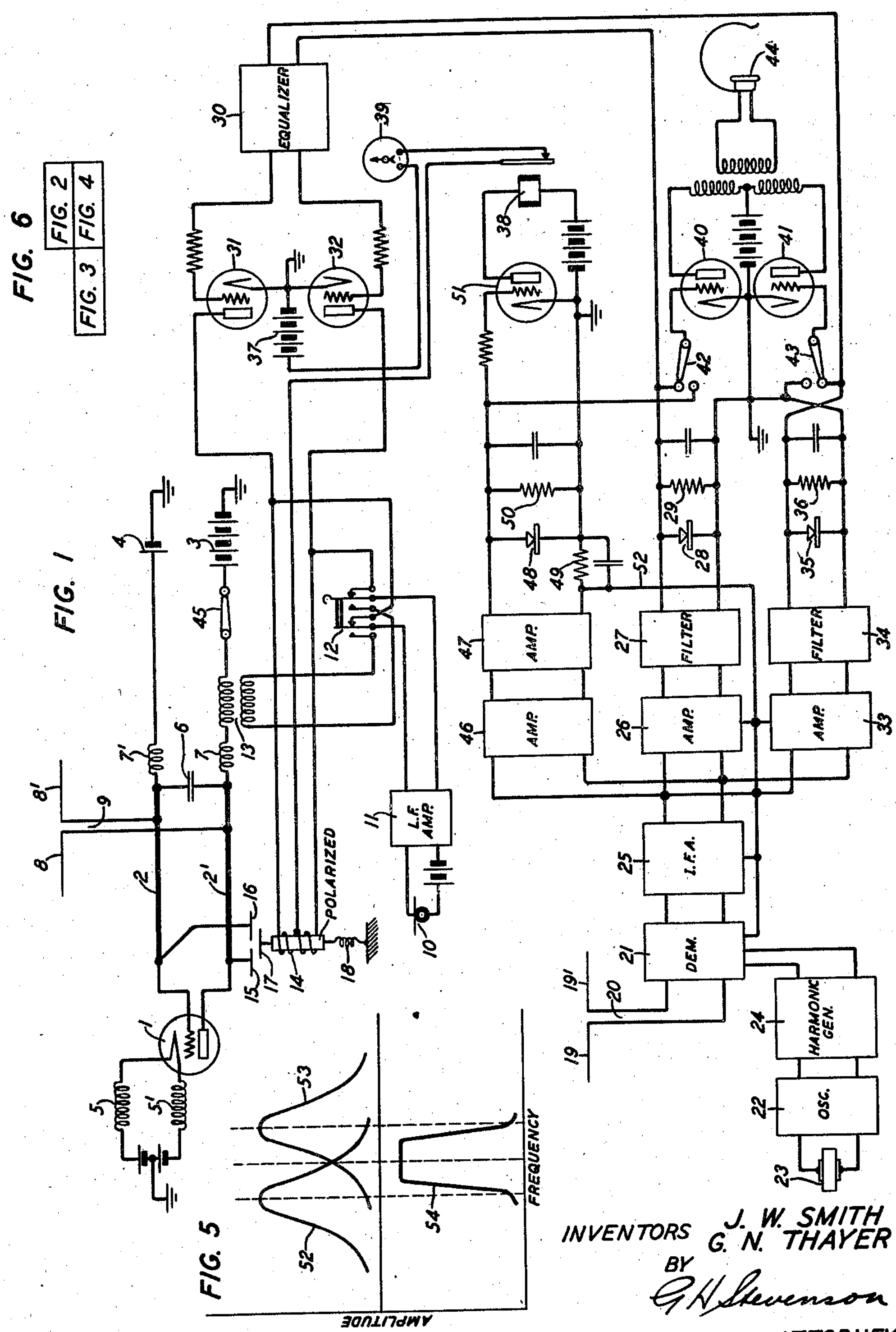
FREQUENCY STABILIZATION SYSTEM

Filed Oct. 17, 1936 4 Sheets-Sheet 1



INVENTORS J. W. SMITH
G. N. THAYER

BY G H Stevenson

ATTORNEY

FREQUENCY STABILIZATION SYSTEM

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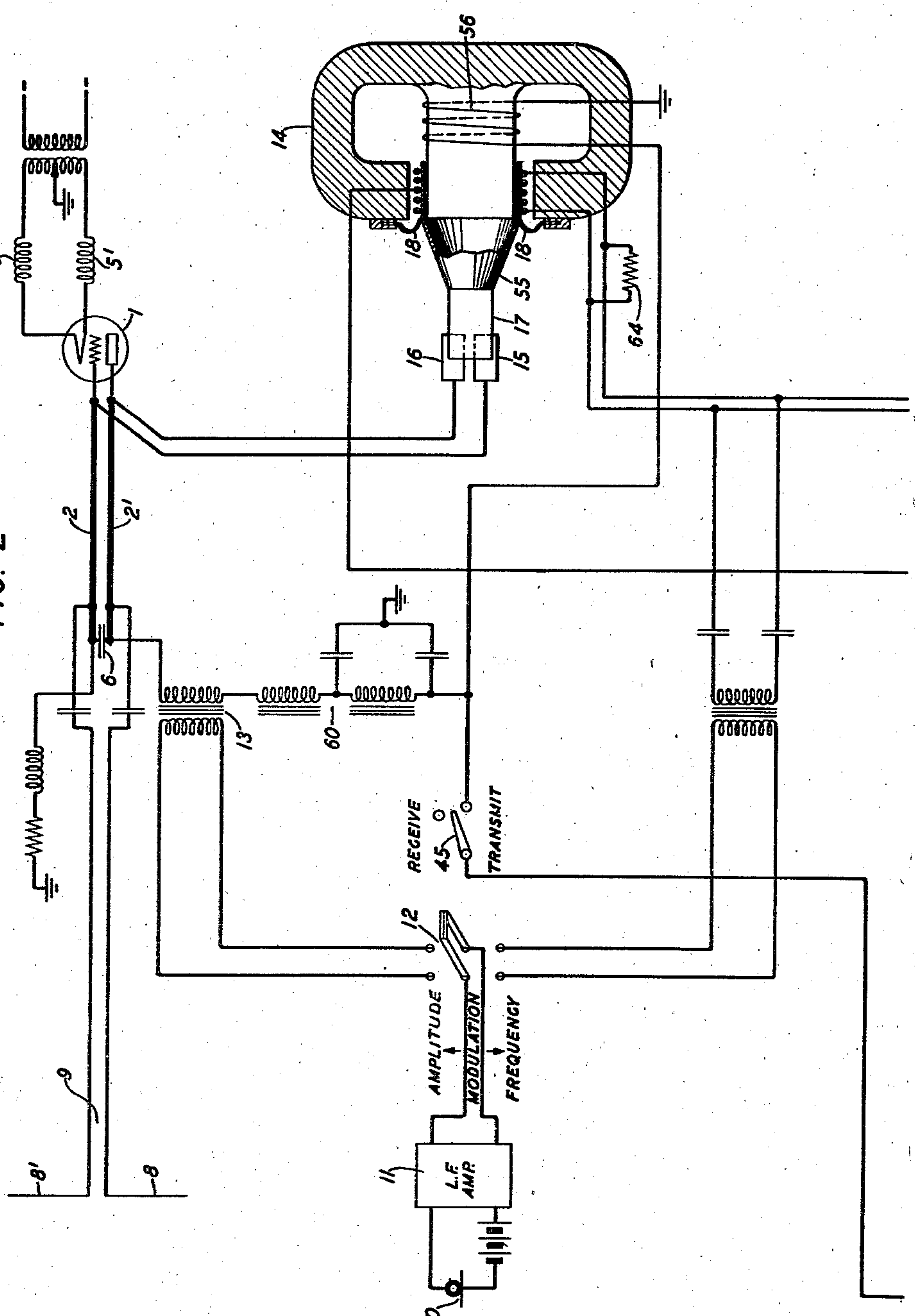
FIG. 2



INVENTORS J. W. SMITH
G. N. THAYER
BY
G H Stevenson
ATTORNEY

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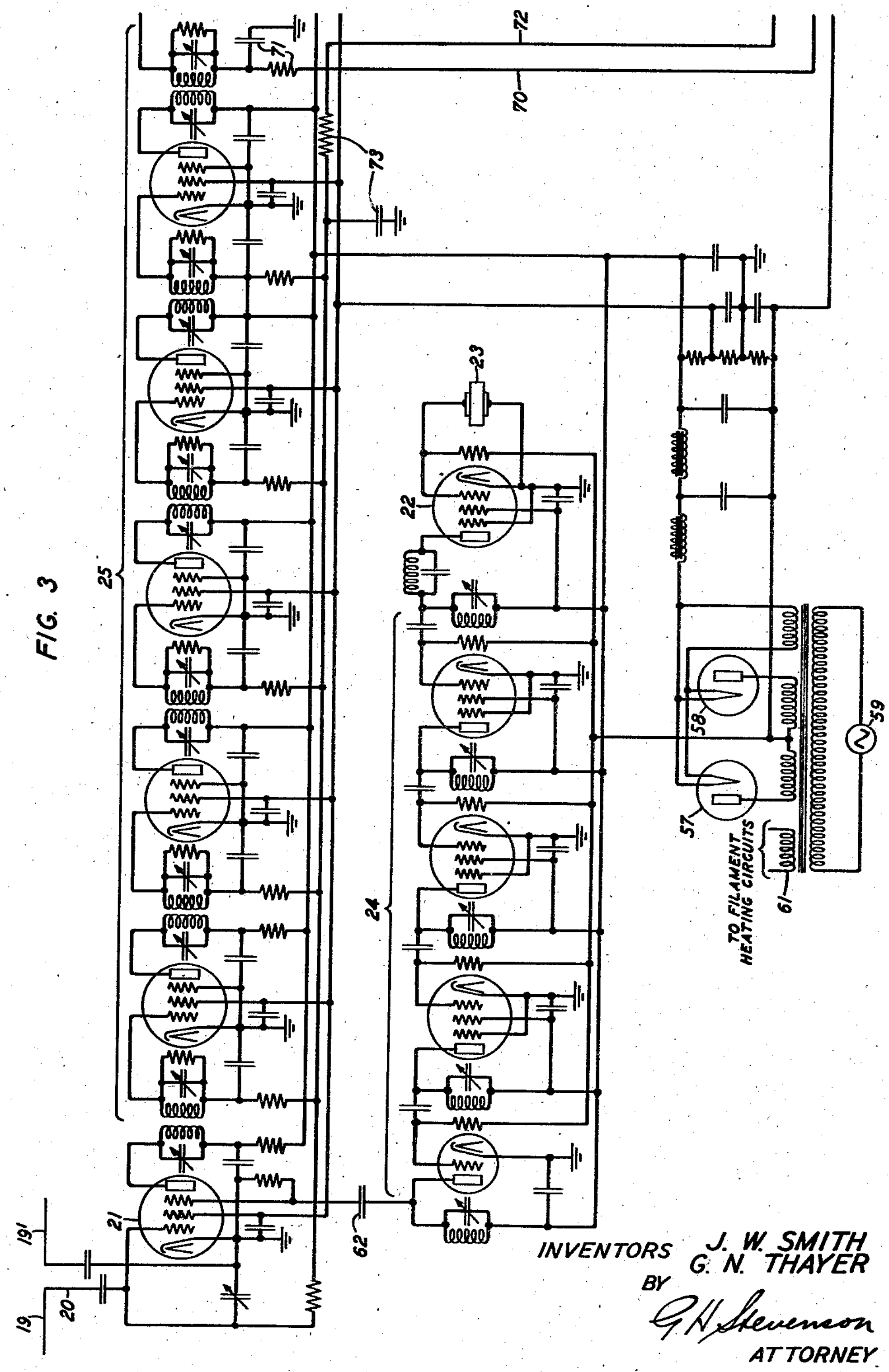
FIG. 3



INVENTORS J. W. SMITH
G. N. THAYER
BY G. H. Stevenson
ATTORNEY

FREQUENCY STABILIZATION SYSTEM

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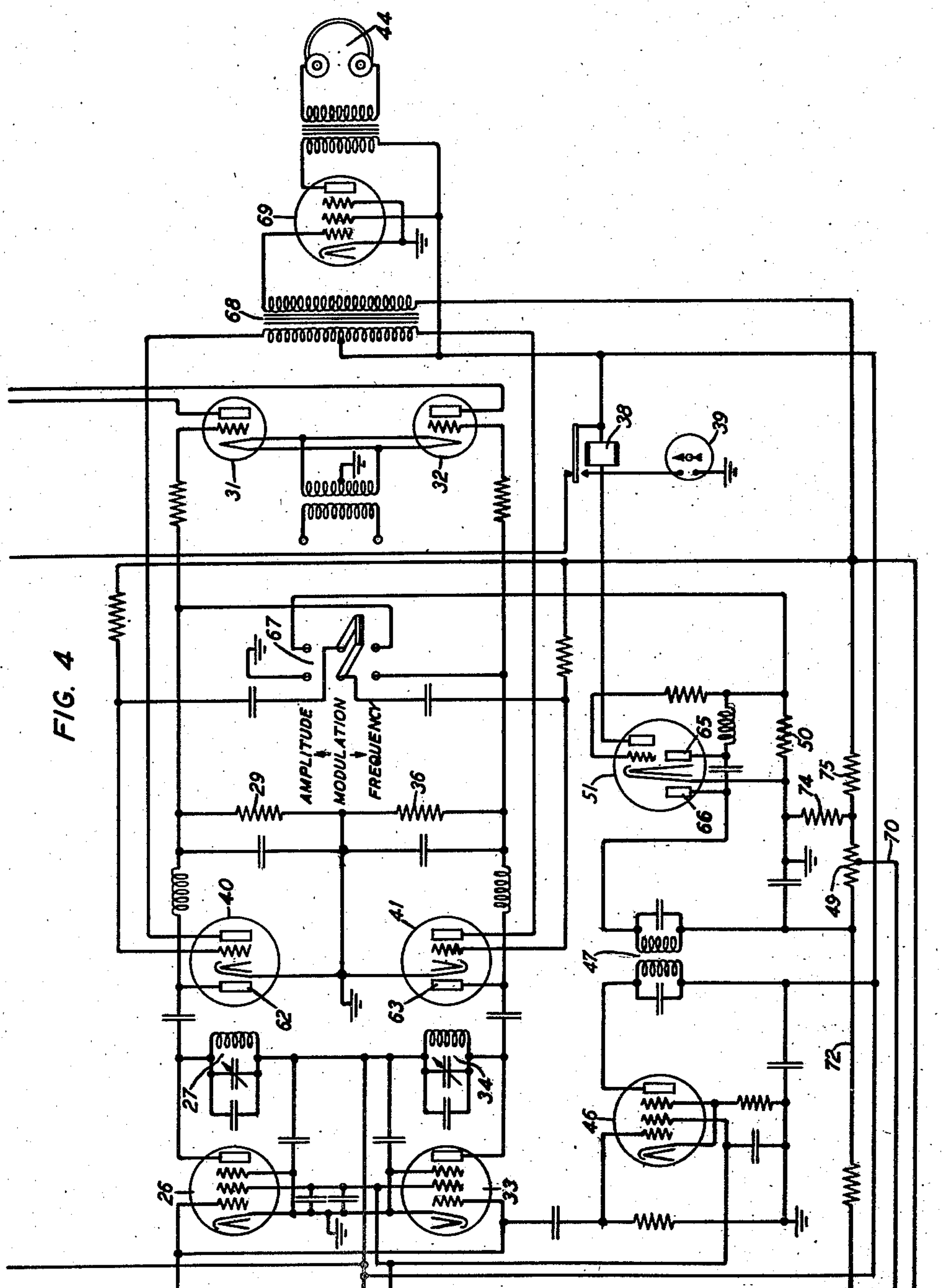

FIG. 4

INVENTORS J. W. SMITH
G. N. THAYER
BY
G. H. Stevenson
ATTORNEY

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FREQUENCY STABILIZATION SYSTEM

John W. Smith, Merristown, and Gorden N. Thayer, Glen Ridge, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 250—13)

This invention relates to high frequency communication systems and more particularly to frequency stabilization means therefor.

The principal object of the invention is to effect the stabilization of the carrier frequency in very high frequency communication systems, another object is to stabilize the mean frequency of the carrier wave in frequency modulation systems, and a third object is to eliminate or reduce unwanted frequency modulations in amplitude modulation systems. A further object is the elimination of distortion producing frequency variations in frequency modulated systems.

In signaling systems designed to operate at very high frequencies, for example, at frequencies corresponding to radio waves of the order of one meter or less in length, modulation of the carrier wave may be effected by varying either its amplitude or its frequency in proportion to the strength of the modulating signal. In the case of amplitude modulation it is desirable that the carrier frequency be stabilized at a constant preassigned frequency and in the case of frequency modulation it is desirable that the mean frequency of the carrier be held constant.

When frequency modulation is used, the carrier wave generator is preferably an oscillator of a type such that the frequency generated can be varied readily through a wide range under the influence of an applied signal voltage. Fixed frequency oscillators, such as piezoelectric crystal controlled oscillators, are not suited for this purpose and other available types are subject to slow variations which, at very high frequencies, may amount to a very large number of cycles. By the present invention these slow drifts of a frequency modulated oscillator are substantially prevented while at the same time the desired frequency variations in accordance with the modulating signal are retained.

In amplitude modulation systems operating at the very high frequencies indicated above, relatively large power outputs are obtained most conveniently by means of an oscillation generator coupled to the radiating antenna and oscillating directly at the carrier frequency. Crystal controlled oscillators are not well adapted to such high frequencies because of the minute dimensions of the crystals required. Furthermore, oscillation generators of the available types for operation at these frequencies are generally subject to large simultaneous frequency modulations when amplitude modulation is attempted. The control system of the invention substantially removes the unwanted frequency modulation without affecting the amplitude modulation.

These results are accomplished in accordance with the invention by a feedback system which picks up part of the radiated wave, analyzes the frequency variation thereof, converts the frequency variations into corresponding amplitude variations of a control current, and applies the control current variations to the oscillator in which the radiated wave is generated in such manner and in such phase as to oppose the frequency change.

In the application of the invention to a frequency modulation system, the varying control current is fed back to the frequency modulating device or, in effect, to the modulating signal input circuit. The control current preferably reproduces all of the signal variations together with any other frequency deviations that may occur, for example, slow changes due to instability and other causes. The feedback is then of a stabilizing character and the system is analogous to the stabilized feedback amplifier described by H. S. Black in an article entitled "Stabilized Feedback Amplifiers", Bell System Technical Journal, January 1934. By the use of a strong feedback or control applied in reverse phase to the signal input, undesired frequency deviations are substantially eliminated.

As stated above, preferably the whole of the detected signal and the accompanying undesired variations are fed back to exercise the stabilizing control. However, it is possible and may, in some cases, be desirable to feed back only the slow variations for the purpose of preventing slow drifts of the mean frequency. This may be accomplished by a slight modification of the invention.

When the invention is applied to amplitude modulation systems, the feedback or control is not impressed on the signal input circuit, but on an auxiliary frequency control means through which it exerts a quick acting compensating control of the frequency.

Since the stabilizing system of the invention also acts as a detector for frequency modulated waves, it may be operated as a receiver in conjunction with the transmitter, thereby providing a two-way transmitting and receiving equipment in which frequency stabilization of the transmitter is accomplished with a minimum of apparatus.

Other features of the invention relate to limiting the range of operation of the frequency stabilization equipment and indicating the operative condition; to switching arrangements whereby either frequency modulation or amplitude modulation may be used as desired; and to means for removing amplitude modulations in a received frequency modulated wave.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawings, of which

Fig. 1 is a functional schematic of a complete station for two-way radio communication embodying the invention;

Figs. 2, 3, and 4 when fitted together as shown in Fig. 6 constitute a more detailed schematic representation of such a station; and

Fig. 5 shows the response curves of filters used in the system.

The system shown schematically in Fig. 1 comprises, essentially, a high frequency transmitter arranged for operation either with frequency modulation or with amplitude modulation and provided with feedback circuits for the stabilization of the mean radiated frequency. In addition to this, the system includes switching and circuit arrangements whereby part of the feedback circuit may be utilized for the detection and reception of incoming signals and a guard circuit for limiting the operation of the feedback control. The transmitter portion of the system and its stabilizing circuits will be described first.

The carrier wave generator comprises a triode tube 1 to the grid and plate of which are connected Lecher wires 2 and 2' forming an oscillation circuit. Preferably the oscillation generator is of the negative grid type, in which case, even at extremely high frequencies, the frequency of the oscillations is determined mainly by the reactances of the oscillation circuit. Plate current is supplied to the oscillator tube from battery 3 and a suitable negative bias is applied to the grid by battery 4. Alternatively the negative grid bias may be furnished by the fall of potential due to the plate current in choke coils 5 and 5' inserted in the filament leads. Condenser 6 connected across the ends of the Lecher wires forms a short circuit for the high frequency currents and high frequency chokes 7 and 7' serve further to isolate the oscillation circuit from the current supply circuits. An antenna consisting of a radiating doublet 8, 8' is coupled through a transmission line 9 to appropriate points on the Lecher wires to effect the maximum energy transfer.

Adjustment or control of the carrier frequency is effected by a variable condenser comprising fixed plates 15 and 16 connected respectively to the plate and grid of the oscillator tube and movable plate 17 symmetrically disposed with respect to the fixed plates. Plate 17 is mounted on the moving element of a polarized electromagnetic driving device 14, the details of the condenser and its driving means being shown more fully in Fig. 2. The motion of the plate 17 is restrained by a spring 18 which makes the displacement substantially proportional to the current delivered to the device.

Microphone 10 is connected through a signal amplifier 11 and a two-way switch 12 either to the terminals of device 14 or to a transformer 13, the secondary of which is included in the oscillator plate circuit. When switch 12 is moved to the right the microphone is connected to the actuating winding of device 14. Amplified speech currents from microphone 10 will then produce synchronous displacements of condenser plate 17 proportional to the current intensity, thereby changing the natural period of the oscillator tuned circuit and effecting a variation of the carrier frequency substantially proportional to the signal. When the microphone is connected to transformer 13, by operating switch 12 to the left, the amplified speech voltage is superimposed on the steady plate voltage of the oscillator thereby producing amplitude modulation of the carrier wave.

The feedback circuit includes an antenna consisting of a receiving doublet 19, 19' so placed as to receive waves radiated from antenna 8, 8'. A transmission line 20 couples doublet 19, 19' to a demodulator 21 for transferring the intercepted waves to a lower frequency range by heterodyne demodulation. The frequency reduction accentuates the frequency variations and at the same time facilitates amplification. The necessary beating oscillations for heterodyning are derived from an oscillator 22 controlled by a piezoelectric crystal resonator 23, the frequency of the generated oscillations being multiplied to a suitable high value by means of a harmonic generator 24.

Amplification of the reduced frequency currents to a suitable degree is obtained in a wide band amplifier 25 which provides substantially uniform gain over a frequency range wide enough to accommodate all of the frequency variations likely to be encountered. The intermediate frequency amplifier preferably consists of a large number of stages, as shown in greater detail in Fig. 3, to produce a strong feedback effect.

The portion of the feedback path following the intermediate frequency amplifier includes a detector-converter circuit wherein is developed a control voltage corresponding in magnitude and sign to the variations of the frequency of the carrier oscillations from a preassigned fixed value. The feedback circuit divides into two paths at the output terminals of amplifier 25, one path including buffer amplifier 26, frequency selective filter 27, rectifier 28, and output resistance 29, and the other path including respectively corresponding elements 33, 34, 35, and 36. The elements in the two paths are similar with the exception of the filters 27 and 34. These are designed to produce attenuations which are equal at the assigned value of the mean carrier frequency, but which vary in opposite senses with variations of the frequency therefrom. The filters may be high-pass and low-pass types respectively so proportioned that their attenuation characteristics cross in the ranges of increasing attenuation adjacent the cut-off frequencies. However, for operation at high frequencies, it will generally be more convenient to use simple resonant circuits tuned respectively to frequencies above and below the desired reference frequency. The transmission characteristics of a pair of such tuned circuits are represented by curves 52 and 53 of Fig. 5. The point at which the curves cross represents the frequency at which the intermediate carrier, or its mean value, is stabilized, the actual carrier frequency being equal to this value plus the frequency of the fixed heterodyne wave.

Assuming that the oscillation amplitudes remain constant at the output terminals of amplifiers 26 and 33, the output voltages of filters 27 and 34 will vary in amplitude in opposite senses as the oscillation frequency varies and will be equal at the frequency determined by the intersection of the filter characteristics. Rectification of these voltages by rectifiers 28 and 35 will therefore produce variable low frequency voltages in resistances 29 and 36 corresponding to the frequency variations of the carrier. By connecting the resistances differentially to a common output circuit, a differential voltage is obtained therein which is directly proportional to the frequency deviation from the assigned carrier frequency and which is of sign corresponding to the direction of the deviation.

In order that the input voltages of filters 27 and 34 may be maintained free from amplitude variations, a quick acting automatic volume control, which will be described later, is provided for amplifiers 26 and 33. Volume limiters of known types may also be used, for example, the tubes of amplifiers 26 and 33 may be operated at a point above plate current saturation so that the outputs are held substantially constant.

The differential control voltage derived from the detector-converter circuit is applied to a push-pull direct current amplifier 31, 32, through an equalizer or filter network 30. The output terminals of the direct current amplifier are connected to the actuating winding of control device 14, the connection being so poled as to bring about the proper frequency compensating action. The purpose of equalizer network 30 is to insure that the control currents are maintained in the proper phase relation at all frequencies in the operating range. Usually this network may be omitted since the phase variation in the feedback loop is generally negligibly small.

The stabilizing action of the feedback control may now be described.

Consider, first, the case of frequency modulation, for which the input signal or speech currents are impressed directly upon the frequency control or modulating device 14. Variations of the radiated frequency corresponding to the signal currents are produced by the action of device 14. These variable frequency oscillations are picked up by antenna 19, 19', together with any other variations that may arise in the oscillator itself due to instability or other causes. In the feedback circuit the detector-converter reproduces the signal currents in amplified form together with other current components corresponding to the unwanted frequency variations. All of these currents are fed back into the signal input circuit from the output of amplifier 31, 32, in such phase as to oppose the original signal currents therein.

When the gain in the feedback circuit is large so that a strong feedback is obtained, the net result is a large reduction of the effective signal input voltage as compared with the voltage delivered by the signal amplifier 11. The gain in this amplifier must therefore be made large enough so that the net resultant input is sufficient to produce the desired range of frequency modulation. We have found that with a strong reversed phase feedback, those frequency variations which have their origin in the oscillator itself, and which therefore do not correspond to the signal input, are reduced in magnitude in substantially the same proportion as the effective signal input voltage is reduced by the feedback. By making the feedback very large, the undesired frequency variations may be therefore substantially eliminated. Both slow drifts of the oscillator frequency due to temperature or voltage changes and rapid shifts due to other types of instability are eliminated. A frequency modulated wave is thus obtained from which frequency variations representing signal distortion are eliminated and which is stabilized about a fixed mean frequency. The elimination of the undesired frequency drifts is effected in a manner analogous to the elimination of non-linear distortion in the stabilized feedback amplifiers described in the article by H. S. Black previously mentioned.

In the system illustrated frequency modulation is produced by electromechanical control of the oscillator tuned circuit. Since the stabilizing control currents are fed back to the signal input circuit, it is manifest that the stabilizing action, in the case of frequency modulation, is independent of the particular means used to effect the modulation, whether electrical or mechanical, and of the type of oscillator.

When the system is operated with amplitude modulation, the signal voltage is impressed on the plate of the oscillator vacuum tube through transformer 13. The feedback circuit in this case does not reproduce the amplitude variations of the carrier, because of the amplitude control of amplifiers 26 and 33, but does produce control currents corresponding to frequency variations of the carrier. These will, in general, include variations due to oscillator instability and also unwanted frequency modulations produced by and corresponding to the modulating signal voltage. The control currents are fed back to control device 14, as in the case of frequency modulation, and act thereon to produce a compensating adjustment of the oscillator frequency. Since there is no degenerative feedback to the signal input circuit a less powerful signal input may be used.

For both of the methods of operation described above, it is desirable that the whole of the feedback loop be capable of transmitting freely all of the signal frequencies, for example the voice range, and frequencies down to zero. It is possible by a simple modification to confine the transmission in the feedback loop to very low frequencies, thereby stabilizing the oscillator against slow variations only. This may be accomplished by substituting for the phase equalizer 30 a resistance-capacity filter designed to transmit only direct current and very low frequencies. With this arrangement, however, the stability obtained is much less complete than with the broad-band feedback and the several advantageous operating characteristics mentioned above are not obtained.

In order that the operation of the stabilizing feedback control may be confined to the frequency range between the resonances of the filters 27 and 34 a guard circuit is provided which interrupts the plate current supply to amplifier 31, 32, when the frequency approaches these limits. The guard circuit branches from the output of intermediate frequency amplifier 25 and includes amplifier 46, band-pass filter 47, detector 48, load resistance 50, direct current amplifier 51 and relay 38, the back contact of which controls the plate current supply to tubes 31 and 32. The pass-band of filter 47 lies between the resonance frequencies of filters 27 and 34, as indicated by curve 54 of Fig. 5. When the oscillations lie within this range, relatively large currents are passed to rectifier 48 and a correspondingly large negative voltage is developed across resistance 50. This negative voltage is impressed on the grid of amplifier 51, reducing the plate current and causing relay 50 to release and close the amplifier plate circuit. When the oscillation frequency lies outside the pass-band of filter 47 substantially no current is passed, with the result that relay 38 is operated and the amplifier is disabled. A meter 39 or other indicating device, such as a lamp, in the plate current supply lead shows the condition of the circuit.

The need for the guard circuit occurs when the oscillation generator is started up or is momentarily interrupted in the normal routines of operation. During the intervals when the cathode temperature and the plate voltage of the oscillator tube are being established, the oscillation frequency varies through a very wide frequency range. If the stabilizing control were permitted to operate before the frequency has reached a value within the operating range of the converter filters, its action would be reversed and the operation would tend to drive the oscillation frequency towards either a zero or an infinitely large value. If the filters could be made to have continuously rising characteristics, this could not happen. Such filters, however, are difficult and costly to construct for operation at radio frequencies. Wide frequency variations may also occur when the oscillator plate voltage is applied after the cathode has been fully heated. In this case the frequency reaches approximately its normal value very rapidly.

The guard circuit also serves to provide automatic volume control for the amplifiers of the feedback path. For this purpose a resistance 49 shunted by a condenser of low capacity is inserted in series with rectifier 48 and the output of filter 47. The rectified current develops a negative voltage in this resistor which is transmitted by conductor 52 to the several amplifiers 25, 26, 33 and demodulator 21 and is applied to the grids of the vacuum tubes thereof. The capacity in shunt to resistance 49 should be large enough to act as a by-pass for the carrier frequency currents, but not large enough to reduce the signal frequency variations of the rectified voltage. The rapidity of the control may be adjusted by suitable resistance-capacity filters which may be included within the amplifiers. For demodulator 21 and amplifier 25 the volume control should be sufficiently slow in action to permit amplitude variations of signal frequency to occur. In the case of amplifiers 26 and 33, the control should be very rapid so that all signal or speech frequency variations of the amplitude are wiped out. By this means the amplitudes of the inputs to the converter filters 27 and 34 are maintained substantially constant.

The feedback portion of the circuit may also be used for the reception of signals from a distant station operating on the same frequency as the carrier oscillator. For this purpose a push-pull signal amplifier 40, 41 is connected by switches 42 and 43 to the output of the detector-converter, the amplifier output being coupled to a telephone receiver 44. While receiving, the transmitting oscillator may be disabled by interrupting its plate current supply by means of transmit-receive switch 45. With this connection the system is in condition for the reception of frequency modulated waves. For the reception of amplitude modulated waves, switch 42 is arranged to connect amplifier 40 in parallel with the input of guard circuit amplifier 51 and switch 43 is operated to disable amplifier 41.

With two systems of the above type operating on the same frequency, a two-way communication channel can be established. Switching from the transmitting condition to the receiving condition is effected by the operation of the single switch 45. Changing from frequency modulation to amplitude modulation is effected by the operation of switches 12, 42, and 43.

In a typical example, the carrier oscillator was designed to operate at a frequency of 300 megacycles per second. The heterodyne frequency furnished by harmonic generator 24 was 295 megacycles, the intermediate frequency of the feedback currents being five million cycles per second. Filters 27 and 34 were designed to have their characteristics cross at this frequency and to have their resonances separated by about 400,000 cycles. The degree of stability obtained was thus substantially that of the crystal oscillator 22, since any variations of the control point of filters 27 and 34 could affect only the relatively low intermediate frequency and could affect that only to a very small extent.

Details of the circuits of the complete system of Fig. 1 are shown in Figs. 2, 3, and 4, which fit together in the manner indicated by Fig. 6. Fig. 2 shows the circuits of the carrier wave oscillator and constructional features of the tuning control device 14. Fig. 3 shows the circuits of the heterodyne generator comprising oscillator 22 and harmonic producer 24 and of demodulator 21 and intermediate frequency amplifier 25. Fig. 4 shows the remaining portion of the feedback circuit and the guard circuit.

In its preferred form, as shown in Fig. 2, the tuning control device 14 is of the electromagnetic moving coil type. The movable condenser plate 17 is attached rigidly to the supporting frame 55 of the moving coil, its plane coinciding with the coil axis. Fixed plates 15 and 16 are disposed symmetrically with respect to plate 17 and parallel thereto with about 50 per cent overlap for the normal position of the coil. Motion of the coil along its axis thus varies the capacity between plates 15 and 16 substantially proportionally to the displacement of the coil. Springs 18 act as the coil restraint and also serve to hold it centrally in the magnet air-gap. Resonance of the moving system may be prevented by applying mechanical damping thereto, for example, by covering the surfaces of springs 18 with dissipative material, such as felt, or with a thin coating of lead. The damping should not be great enough to prevent response of the device at any frequency in the signal range. Alternatively, electrical damping may be provided by a suitable resistance 54 connected across the moving coil terminals. A field winding 56 is provided for polarizing the magnetic circuit.

The power for all of the vacuum tubes and for magnet winding 56 is supplied by full-wave rectifier 57, 58, Fig. 3, and an associated smoothing filter, connected to a 60 cycle alternating current source 59. A separate winding 61 is provided on the power input transformer for energizing the vacuum tube cathodes. An additional smoothing filter 60 is included in the oscillator plate supply circuit as a further precaution against unwanted frequency modulations. The cathodes of all of the vacuum tubes except the guard circuit input amplifier 46 are connected to ground at a point intermediate the positive and negative potentials of the power supply.

Harmonic generator 24 comprises three frequency multiplying stages each using screen-grid pentode tubes with indirectly heated cathodes. The output circuit of oscillator 22 is so arranged that a harmonic of the generated frequency is supplied to the input of the harmonic generator, thereby securing additional frequency multiplication. Demodulator 21 also uses a screen-grid pentode tube with indirectly heated cathode, the incoming oscillations being impressed on the control grid and the heterodyne oscillations on the suppressor grid between the screen and the anode. Intermediate frequency amplifier 25 comprises five pentode stages coupled together and to the demodulator by double tuned circuit broad-band filters.

The output of amplifier 25 is fed into buffer amplifiers 26 and 33 in the plate circuits of which are connected the converter filters 27 and 34. These filters consist of simple anti-resonant circuits tuned to different frequencies and proportioned to provide response characteristics intersecting in the manner shown by curves 52 and 53. The rectifiers shown at 28 and 35 in Fig. 1 are constituted by the space paths between auxiliary anodes 62 and 63 and the cathodes of tubes 40 and 41, which are of the diode-triode type. The switches 42 and 43 of Fig. 1 are combined in a two-way double throw switch 67. The output of amplifiers 40 and 41 goes to transformer 68 and thence through an additional low frequency amplifier 69 to telephone receiver 44. Guard circuit amplifier 46 has its control grid excited in parallel with amplifiers 26 and 33 by the output of amplifier 25. Band-pass filter 47 comprises a pair of tuned circuits suitably coupled to provide the desired pass-band. Rectifier 48 is constituted by the space paths between auxiliary anodes 65 and 66 of amplifier tube 51 which is a double diode-triode. Electrodes 65 and 66 are connected together through a condenser, the output of filter 47 being connected to anode 66. Resistance 50 from which the grid of tube 51 is excited is connected in shunt between diode 65 and the tube cathode. A small high frequency choke coil is included in series with this resistance to suppress the carrier frequency currents. Resistance 49 in which the automatic volume control potential is developed is included in series between the output of filter 47 and the cathode of the tube. Connections from taps in this resistance are led to the grids of the several controlled amplifiers and provide volume control voltages of suitable magnitudes therefor. Lead 70 supplies the control voltage to the grids of amplifiers 26 and 33 through filter 71, the time constant of which is made sufficiently small so that signal frequency variations are transmitted. Control bias is supplied to the tubes of amplifier 25 and demodulator 21 through lead 72 and filter 73, the time constant of which is large enough to permit only slow variations to be transmitted. A steady initial grid bias for all of these tubes is provided by the fall of potential in resistance 74 which is connected in series with resistance 75 between the negative terminal of the power supply rectifier and the cathodes. The indicator 39, meter or lamp, is included in an auxiliary circuit connected to the front contact of relay 50 rather than directly in the amplifier plate current circuit as in Fig. 1.

What is claimed is:

1. In a high frequency communication system, a carrier wave generator, a source of signal oscillations, means for impressing oscillations from said source upon said generator whereby the frequency of the generated carrier wave is modulated in accordance with the signal oscillations, means for detecting the frequency modulations of the carrier wave in the output of said generator, means for deriving from said detected frequency modulations currents having corresponding strength variations, and means for superimposing said varying strength currents upon the oscillations from said signal source to counteract the frequency modulation of the carrier wave.

2. In a high frequency communication system, a carrier wave generator, means for modulating the frequency of said generator in accordance with signal currents, a source of signal currents, a signal input circuit coupling said source and said modulating means, a feedback path coupling the output of said generator and said signal input circuit, said feedback path including means for reproducing from the carrier wave currents having strength variations corresponding to the frequency modulations thereof, and means for impressing said varying strength currents upon said input circuit, the transmission characteristic of said feedback path and its connection to said input circuit being such that the fed back currents are in substantially opposite phase relation to the signal currents from said source and are approximately equal thereto in magnitude.

3. A system in accordance with claim 2 in which the said modulating device is responsive to signal frequency currents and frequencies down to zero, and in which the feedback path is responsive to frequency variations at corresponding rates.

4. In a high frequency communication system, a carrier wave oscillator comprising a tuned circuit which determines the frequency of the generated waves, a variable tuning element in said tuned circuit, means determining a substantially fixed frequency, means for automatically adjusting said tuning element in response to departures of said oscillator from said fixed frequency, and means simultaneously controlling said tuning element in accordance with signals.

5. In a high frequency communication system, a carrier wave oscillator comprising a tuned circuit which determines the frequency of the generated waves, a variable tuning element in said tuned circuit, means for determining a substantially fixed frequency, means for varying said tuning element in accordance with signals, means detecting departures of the oscillator from the fixed frequency, said detecting means being operative over a range of frequencies including the signals, and means for automatically adjusting the tuning element in response to frequency departures of signal and non-signal origin.

6. In a high frequency communication system, a carrier wave oscillator comprising a tuned circuit which determines the frequency of the generated waves, a variable tuning element in said tuned circuit, means determining a substantially fixed frequency, means for varying said tuning element in accordance with signals, means for detecting departures of the oscillator from the fixed frequency, said detecting means being responsive to slow departures of frequency and to departures at signal rates, and means for automatically adjusting said tuning element in response to said departures of both kinds.

7. In a high frequency communication system, a carrier wave oscillator comprising a tuned circuit which determines the frequency of the generated waves, a variable reactance element in said tuned circuit, means determining a substantially fixed frequency, slow acting means for automatically adjusting said variable element in response to slow departures of the said oscillator frequency from said fixed frequency and separate means for controlling said variable element in accordance with signals.

8. In a combined transmitting and receiving

station for high frequency communication, a carrier oscillator comprising a tuned circuit which determines the frequency of the generated waves, a variable reactance element in said tuned circuit, a transmitting antenna connected to said oscillator, a detector of frequency fluctuations, a receiving antenna connected to said detector and exposed to the influence of said transmitting antenna, control means actuated by the detector to automatically adjust said variable element to maintain the generated frequency substantially constant, a telephone receiver also actuated by the detector to reproduce signals in accordance with frequency fluctuations, and means to disable the carrier oscillator during reception of waves from another station.

9. In a frequency stabilized oscillator system comprising an oscillator generator, frequency correcting means therefor, means determining a substantially fixed frequency, and means for automatically adjusting said correcting means in response to departures of the generated frequency from said fixed frequency, an auxiliary transmission path coupled to the output of said generator and responsive to impressed oscillations in a limited range of frequencies centered about said fixed frequency, and current responsive means in the output of said path for disabling said corrective means when the frequency of the generated oscillations lies outside said limited range.

JOHN W. SMITH.
GORDON N. THAYER.