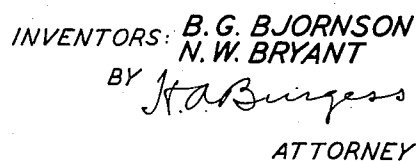


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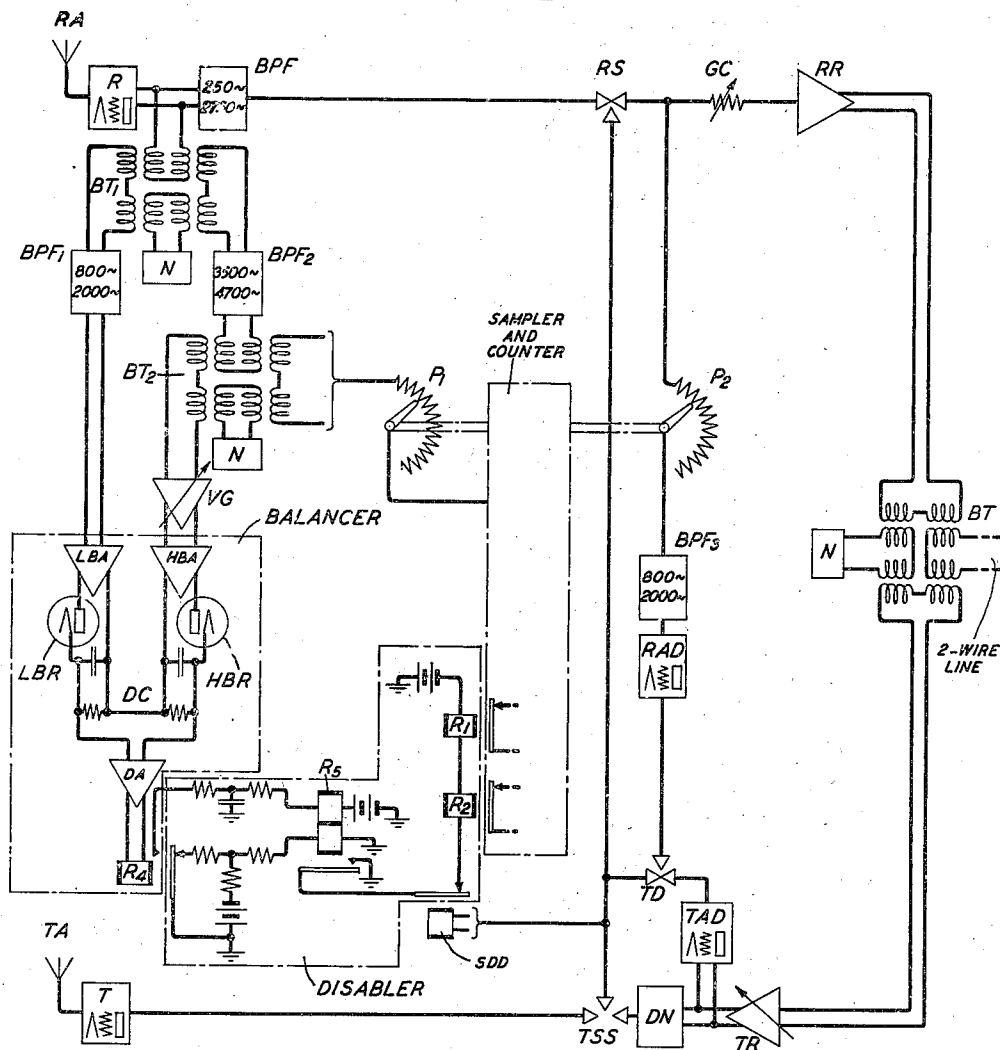
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TWO-WAY SIGNALING SYSTEM

Filed Dec. 10, 1936

4 Sheets-Sheet 2

FIG. 2



INVENTORS: B. G. BJORNSON
N. W. BRYANT

BY *H. A. Burgess*

ATTORNEY

March 29, 1938.

B. G. BJORNSON ET AL

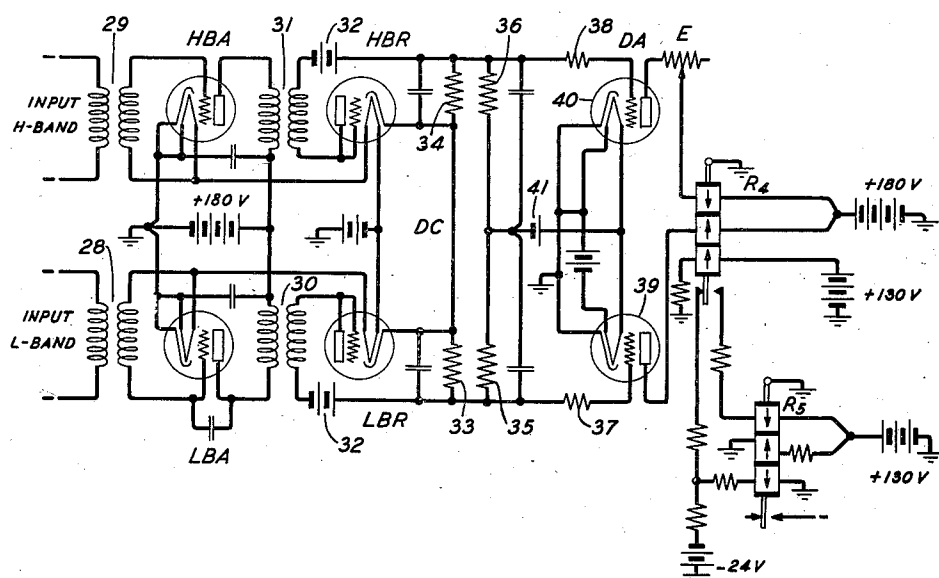
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TWO-WAY SIGNALING SYSTEM

Filed Dec. 10, 1936

4 Sheets-Sheet 3

FIG. 3



INVENTORS: B. G. BJORNSON
N. W. BRYANT
BY *J. A. Burgess*
ATTORNEY

March 29, 1938.

B. G. BJORNSON ET AL

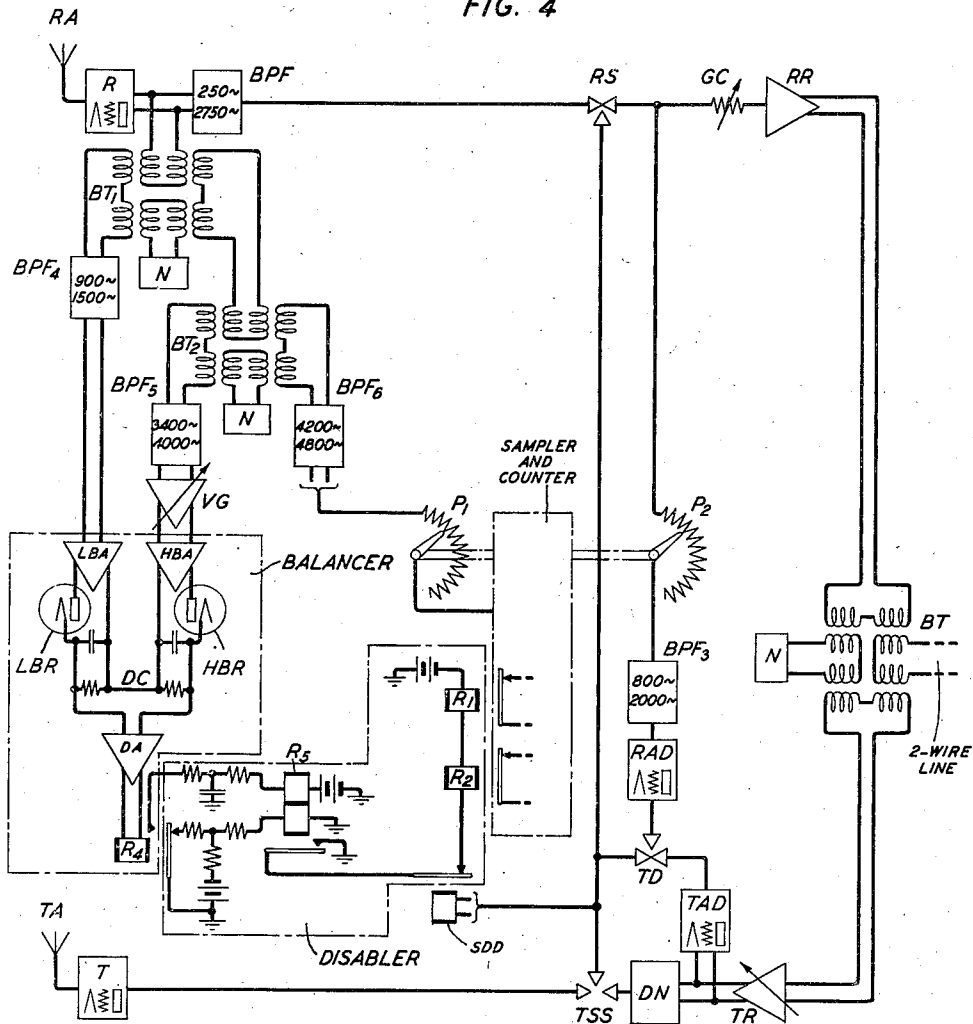
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TWO-WAY SIGNALING SYSTEM

Filed Dec. 10, 1936

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FIG. 4



INVENTORS: B. G. BJORNSON
N. W. BRYANT
BY *H. A. Burgess*
ATTORNEY

UNITED STATES PATENT OFFICE

2,112,515

TWO-WAY SIGNALING SYSTEM

Björn G. Björnson, New York, N. Y., and New
ton W. Bryant, Lyndhurst, N. J., assignors to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application December 10, 1936, Serial No. 115,092

12 Claims. (Cl. 178—44)

This invention relates to two-way signaling systems and particularly to signal-controlled circuits employed for directionally controlling signal transmission in such systems.

5 An object of the invention is to improve the operating characteristics of two-way signal transmission systems utilizing therein signal-operated apparatus for suppressing echoes.

10 The present invention is related to systems such as the Echo suppressor control system disclosed in the copending application, Serial No. 111,933, filed November 20, 1936, of Lionel Schott, and has particularly to do with the provision of certain improved features capable of use in such systems.

15 In two-way telephone communication systems in which the two paths of a four-wire circuit are used for communicating in opposite directions, it is customary to employ apparatus for suppressing echoes. These are voice-operated devices which serve to maintain disabled either path of a two-way circuit when voice currents are being transmitted over the other. Such an arrangement is for the purpose of preventing disturbing reflections and reflections of voice energy which are ordinarily produced by electrical irregularities in the circuit, such for instance as those which arise from imperfect balance in the conjugate transformers where the two-path or four-wire sections and the two-wire or single path sections of the communicating circuit are connected together.

20 The return time of an electrical echo may be short or long, depending upon the transmission time to and back from the electrical irregularity in the circuit. The voice-operated device must be speedy enough in its operation to disable or prevent the clearing of the opposite transmission path before the quickest echo returns and must remain operated for a sufficient length of time to keep the opposite transmission path disabled during the interval required for the slowest or most distant echo to return. The time interval between the cessation of the operating impulse and the removal of the disability by the voice-operated device is commonly referred to as the "hangover" time.

25 In a communication system where the two ends of the four-wire or two-path portion of the circuit are geographically remote from each other, as in the case of a long wire transmission line or a line including a radio link, it is customary to provide at one or the other or both termini of the two-path portion a voice-operated device operated by the receiving path impulses at that

end for disabling the transmitting path, or for preventing the clearing of a normally disabled transmitting path, and a voice-operated device operated by the transmitting path impulses for disabling the receiving path. The hangover time of the voice-operated device operated by the receiving path impulses may ordinarily be made from two one-hundredths to fifteen one-hundredths of a second, depending upon the echo return time; and the hangover time of the voice-operated device operated by the transmitting path impulses may ordinarily be in the neighborhood of fifteen one-hundredths of a second. Assuming that the hangover time of the receiving voice-operated device is four one-hundredths of a second, the operation of the device is such that the transmitting path remains disabled for that length of time after the cessation of the last operating impulse in the receiving path. It is only after the expiration of this hangover interval that the voice impulses can pass over the transmitting path.

30 The receiving voice-operated device is not only operated by the ordinary received voice impulses in its intended way, but it may also be operated improperly by impulses produced by noise occurring in the incoming receiving path. Where the communicating circuit includes a radio link, the disturbances which are commonly referred to as "static" constitute the major source of such noise. In such a circuit the static is always present to a greater or less degree, and the static crashes sometimes rise to a considerable magnitude in their energy level. If the energy of the static in the frequency band over which communication is taking place is of sufficient magnitude, it causes a false operation of the receiving voice-operated device, and this causes the disabling of, or prevents the removal of a normal disability from, the opposite or transmitting path for a length of time at least equal to the hangover time of the receiving voice-operated device. Under certain conditions there results a clipping or complete elimination of transmitted speech syllables. When such occurrences cause loss of speech intelligibility, the sensitivity of the receiving voice-operated device must be decreased so that the number of false operations is reduced.

35 In the usual practice heretofore the need for such sensitivity adjustments has required the constant attention of a technical operator who makes such adjustments manually. In making the adjustments the technical operator has been guided by the visual indication of a meter con-

trolled by the receiving voice-operated device and by a monitoring observation of the effect of the clipping or mutilation upon the intelligibility of the transmitted speech. It has been found that when the adjustments are thus made manually, the tendency is to make the sensitivity of the voice-operated device unnecessarily low. As this also requires that proportionate attenuation be introduced into the receiving branch of the communicating circuit to prevent improper operation of the transmitting voice-operated device by energy transmitted through the conjugate transformers, it results in the delivery of an unnecessarily low received speech volume to the subscriber.

In accordance with the present invention the adjustment of the sensitivity of the receiving voice-operated device is made automatically and at frequent intervals, and in proportion to the relation which exists from time to time between the number of noise or static operations that occur and are recorded during a cycle of short testing or sampling intervals each bearing a definite relation to the hangover time of the voice-operated device and a predetermined tolerable number of such operations. It is only when noise or static impulses occur in the receiving path during a time interval equal to the hangover time, and immediately preceding the passage of a word or syllable over the transmitting path, that such impulses may cause the clipping or mutilation of the word or syllable. The noise or static impulses which occur at the time when the transmitting path has control of the line are ineffective to cause speech mutilation, because during such time the receiving voice-operated device is disabled and irresponsive to them. Such noise or static impulses are also ineffective if they occur during the major portion of the period during which the speech or signal impulses are not actually being transmitted over the transmitting path. It is only when a noise or static impulse occurs and takes control of the receiving voice-operated device during a time interval equal to the hangover time immediately preceding the start of transmission over the transmitting path that the transmitting path is momentarily blocked and the word or syllable is clipped or mutilated. The probability of mutilation therefore is the probability of a static impulse occurring in a time interval equal to the hangover time of the receiving voice-operated device.

It has been ascertained, however, that an occasional clipping of a syllable to a slight extent may be tolerated without serious degradation of the speech. The extent to which a syllable may occasionally be clipped without interfering with the intelligibility of speech depends upon the length and nature of the syllable. We have found that the effects upon transmitted speech of an occasional clipping of syllables by as much as two-hundredths of a second are negligible, and that as high as eighteen to twenty-five per cent of the first syllables of the first words of a series of talk spurts may be clipped by something more than two one-hundredths of a second before the operation of the transmission circuit becomes uncommercial. A talk spurt is a period of sustained talking to provide voice currents of at least a certain level. In the above case it is to be understood that the hangover time of the receiving voice-operated unit is four one-hundredths of a second. It follows therefore that not every static impulse that falls within this time interval immediately preceding the passage

of a syllable over the transmitting path will seriously mutilate the syllable. Such impulses as occur in the first half of the four one-hundredths of a second interval will block or prevent the clearing of the transmitting path for not to exceed two one-hundredths of a second after the syllable to be transmitted starts. It is only those impulses which occur in the second half of the four one-hundredths of a second interval which can cause the clipping of the transmitted syllable by an amount greater than two one-hundredths of a second.

Therefore the probability that a static operation of the receiving voice-operated device will seriously mutilate a speech syllable is the probability that the static operation will occur in a time interval equal to the hangover time of the suppressor unit reduced by a time amount that corresponds with the negligible extent of the occasional clipping of a syllable. Thus when the hangover time is four one-hundredths of a second, and the negligible amount by which a syllable may be clipped is two one-hundredths of a second, the difference between these intervals, amounting to two one-hundredths of a second, becomes the time interval upon which the probability of speech mutilation by static operation may be based. Again, if the hangover time of the receiving voice-operated unit is six one-hundredths of a second, the difference between this and the negligible occasional clipping time of two one-hundredths of a second is four one-hundredths of a second. Therefore in this case four one-hundredths of a second is the length of the time interval upon which the probability of speech or signal mutilation by static operation may be based.

In accordance with the present invention the method is to measure the probability of static operation by sampling the static throughout an extended series of time intervals each of a length equal to the difference between the hangover time of the receiving voice-operated device and the negligible occasional clipping time, and then to effect an automatic adjustment of the sensitivity of both the receiving voice-operated device and the sampling device in accordance with the relation which the ratio of static operations to the total number of sampling operations bears to the predetermined tolerable ratio between such operations. If the ratio is greater than the tolerable ratio, the sensitivity of both the receiving voice-operated unit and the sampling unit is reduced; if the ratio is less than the tolerable ratio, the sensitivity of both units is increased.

The present invention further provides for continuously carrying on the testing or sampling operation and the automatic sensitivity adjustment during the time when the communicating circuit is in use. Where the total frequency band width is great enough to permit, as in short-wave radio, provision is made for conducting the testing or sampling operation in a portion of the wide frequency band different from the portion of the band that is employed for communication and for the operation of the receiving voice-operated device. We have found that there is relatively little variation in the distribution of static energy in two frequency bands of the same width and located relatively close together in the frequency spectrum when the comparison extends over a relatively long time interval. There may be short time variations of static energy as between the bands, the static crashes sometimes falling in one band and sometimes in another.

But where a sufficiently large number of samples is taken the static energy distribution indicated in the band used for sampling is representative of the static energy distribution in the other band used for speech. This fact is utilized in the sampling and automatic sensitivity adjusting system of the present invention.

Where the sampling is carried on during communication in a portion of the frequency band lying near the portion of the band which is used for communication, we have found that incoming speech syllables of a large energy intensity have, or produce, harmonics which fall in the sampling band and may be recorded as static and cause false operations of the sampler. To eliminate false indications which would otherwise result from the occurrence of such speech harmonics in the sampling band and which would cause improper sensitivity adjustments, we provide a disabling circuit, connected in a portion of the speech frequency band, which operates automatically to suspend the sampling operations when the speech energy rises to high amplitudes. Improper operation of the disabling circuit by strong static occurring in the speech frequency band is prevented, in accordance with one form of our invention, by a differential circuit that balances the rectified energy in the sampling band against that in the speech band. In another form it is prevented by automatically introducing loss or attenuation in the portion of the frequency band which operates the disabling circuit when the static rises above a predetermined intensity.

A more complete understanding of the invention with its various objects and features will be had from the following detailed description when read in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a control terminal of a four-wire radio telephone circuit equipped with a voice-operated device for adjusting sensitivity in accordance with the principles of this invention;

Fig. 2 is a diagrammatic representation of a radio telephone control terminal employing a modified arrangement of the sensitivity adjusting apparatus;

Fig. 3 is a diagrammatic detail of a portion of the circuit illustrated in Fig. 2; and

Fig. 4 is a modification of Fig. 2.

The same reference numerals have been employed to designate identical elements appearing in the several figures of the drawings.

The diagrams of Figs. 1, 2, and 4 are in part actual circuit diagrams, and in part single line schematic layouts in which each line indicates a two-wire circuit. In the single line portions of the diagrams a normal make in a circuit is indicated by contacting arrowheads and a normal break in a circuit by separated arrowheads. The arrow directed at a make point indicates that the circuit will be disabled at that point by operation of the associated control device, and an arrow directed at a break point indicates that the circuit will be completed at that point by the operation of the associated control device.

Operation of Fig. 1

Fig. 1 illustrates one way in which the present invention may be used in connection with a radio telephone control terminal in which the received noise or static impulses are a limitation upon the operation of the associated voice-operated devices. In the specific case illustrated the

two-wire or single path portion of the communicating circuit is connected with the four-wire or two-path portion of the circuit through the medium of a hybrid coil or balanced transformer network BT. One of the two paths of the four-wire portion of the circuit extends from the balanced transformer network BT to the receiving antenna RA and the other path extends from the balanced transformer network BT to the transmitting antenna TA. R indicates the inclusion in the receiving branch of the usual radio receiving apparatus, and T indicates the inclusion in the transmitting branch of the usual radio transmitting apparatus. Included in the receiving branch is the receiving repeater RR and the adjustable gain control device GC, and included in the transmitting branch is the variable gain transmitting repeater TR. The receiving branch also includes the suppressor switch RS normally under the control of the transmitting amplifier detector TAD. The transmitting branch includes the transmitting short-circuit switch TSS normally governed by the transmitting amplifier detector TAD subject to the control of the transmitting disabler TD, which in turn is under the control of the receiving amplifier detector RAD.

The normal disability of the transmitting path indicated by the break between the arrowheads at TSS is a disability due to a normal short circuit of the conductors of the transmitting path at this point. When a speech or signal impulse flows from the network BT toward the transmitting antenna TA it causes the operation of the transmitting amplifier detector TAD to actuate the switch control TSS to open the short circuit and thus remove the normal disability at this point. The delay network DN is included in the transmitting path to delay the arrival of the speech or signal impulse at the switch control TSS until the more quickly operating control path by way of the transmitting amplifier detector TAD and the transmitting disabler TD has had a chance to operate the switch control TSS to clear the path for the transmission of the impulse to the transmitting apparatus T and transmitting antenna TA.

The energizing path for the receiving amplifier detector RAD and the transmitting disabler TD which it controls is branched off from the receiving path at a point between the suppressor switch control RS and the adjustable gain control GC. When speech or signal impulses start to pass over the transmitting path, the operation of transmitting amplifier detector TAD which operates the transmitting control switch TSS and removes the normal disability from the transmitting path, also operates the control switch RS and disables the receiving path at a point ahead of the connection of the receiving amplifier detector RAD. When impulses are received in the receiving path, they operate the receiving amplifier detector RAD to actuate the transmitting disabler switch control TD, thus preventing the transmitting amplifier detector TAD from acting either to remove the normal disability from the transmitting path TSS or to disable the receiving path at RS. The elements and operations described in the foregoing constitute the customary echo suppressor and anti-singing arrangements of the transmitting and receiving voice-operated devices. The features which are peculiar to the automatic sensitivity control of the present invention will now be described.

Associated with the receiving path is a band-pass filter BPF adapted to pass with minimum at-

tenuation the frequencies lying between 250 cycles and 2750 cycles per second. These are the speech or signal frequencies, and they are normally transmitted by way of the switch control RS, the variable gain device GC and the receiving repeater RR to the network BT where they pass to the two-wire or single path portion of the communicating circuit. The receiving path also has associated with it three other band-pass filters. Through one of these, the filter BPF₃, the frequencies within the speech band ranging from 800 cycles to 2000 cycles per second pass to the receiving amplifier detector RAD for the operations of the transmitting disabler TD. Through another of these filters, the filter BPF₂, passes a band of frequencies ranging, in this particular instance, from 3500 cycles to 4700 cycles per second for the operation of the static sampler apparatus. Through the third of these filters, the filter BPF₁, frequencies ranging from 800 cycles to 2000 cycles per second, the same range as in the case of the filter BPF₃, pass to the sampler disabler apparatus. The bands of frequencies that pass through the filters BPF₁ and BPF₂ are derived from the receiving path by way of the balanced transformer network BT₁. The amplitudes of the energy passing through the three filters BPF₁, BPF₂ and BPF₃ are controlled by the potentiometers P₃, P₁ and P₂, respectively. The arms of these potentiometers are secured to a common shaft which is rotated to simultaneously increase or decrease the amount of current flow in the three potentiometer controlling paths, and therefore increase or decrease the sensitivity of the responsive apparatus connected with the three paths. The rotation of the potentiometer arms in a direction to increase the sensitivity of the associated devices is effected by the increase magnet IM through the medium of the pawl 10 and ratchet 11; and the movement of the potentiometer arms in the reverse direction to decrease the sensitivity of the associated devices is brought about by the decrease magnet DM through the medium of the pawl 12 and ratchet 13.

The decrease magnet DM and increase magnet IM are respectively under the control of the relays DR and IR included in the output circuit of the detector D. The input circuit of the detector D is under the control of the sampler relay SR. The control-grid of detector D is normally biased by battery 14 so that substantially no current flows in the output thereof. In its normal unattracted position the armature of the sampler relay SR rests upon its back contact and applies positive potential from battery 7 to the condenser C₁. When the sampler relay SR operates, a large part of the positive charge stored in the condenser C₁ is transferred to the condenser C₂. The capacity of the condenser C₁ is small and that of condenser C₂ is large, the proportions of the capacities being such that it requires the transfer of many charges from the condenser C₁ to fully charge the condenser C₂, the potential of the condenser C₂ therefore constituting an indication of the number of times the sampling relay SR has operated. As the condenser C₂ is connected in the grid-filament circuit of the detector D, the current flow through the relays DR and IR connected in series in the plate circuit of the detector D changes with the changing potential built up on the condenser C₂, and therefore with the number of operations of the sampling relay SR.

The sensitivity of the relay DR is made less than that of the relay IR by connecting a resistor 75 6 in shunt with the former. Therefore as the

current flow in the plate circuit of the detector D increases the relay IR first operates, and then, upon a further increase of current flow, the relay IR remains operated and the relay DR operates.

It will be noted that a biasing battery 14 is connected in the grid-filament circuit in series with the condenser C₂. This battery is so poled that after the condenser C₂ has been discharged at the end of a sampling cycle the current in output of detector D is substantially zero. The sampling cycle, initiated in a manner which will presently be described, therefore starts with the control-grid of detector D normally biased by battery 14 as previously described. The biasing potential on the grid is gradually reduced as successive increments of positive charge from the small condenser C₁ are transferred by successive operations of the sampler relay SR to the large condenser C₂. Obviously, as the bias on the grid becomes less negative, the current flow in the plate circuit increases.

The sampler relay SR is under the control of the static energy condition existing in the sampling band of frequencies between 3500 and 4700 cycles per second passed by the band-pass filter BPF₂. This band-pass filter has connection with the sampler amplifier detector SAD by way of the transformer network TN, the sampler relay SR being connected in the output of the sampler amplifier detector SAD. The arrangement employed in the transformer network TN is that which is disclosed and described in Patent 1,749,841 to H. C. Silent, issued March 11, 1930. The interconnected windings of the two transformers which constitute the network TN are normally connected in opposing relation so as to introduce high attenuation into the path extending between the band-pass filter BPF₂ and the sampler amplifier detector SAD. Upon the closure of the branch circuit which extends from the interconnected windings, the windings are placed in a series aiding relation so as to afford a substantially unobstructed path for the flow of energy from the band-pass filter BPF₂ to the sampler amplifier detector SAD.

The intervals during which the sampler amplifier detector SAD and the associated sampler relay SR are placed in energy receiving relation with the band-pass filter BPF₂ are the sampling intervals. These sampling intervals are determined by the operation of the contacts 15 associated with the cam CA. This cam is one of two cams on a shaft 8 rotated by the motor M, the speed of this motor being made variable by the adjustment of the rheostat 16. An extension shaft 9 upon which the cams CC, CE and CD are mounted is connected with the shaft 8 upon which the cams CA and CB are mounted through a slipping friction member 17 and a coiled spring 18. The rotation of the extension shaft is normally prevented by the engagement of a latch carried by the armature of the release magnet RM with a tooth on the disc 19 secured to the end of the extension shaft.

On the cam CA there are four cam projections. Therefore, the contacts 15 are closed four times in each revolution of the shaft to establish the energy transmitting condition of the transformer network TN and operatively connect the sampler relay SR with the sampling frequency band. The cam CB has an equal number of correspondingly placed cam projections, so that each time the sampling contacts 15 are closed the contacts 20 associated with cam CB are also closed. These

are the sample counting contacts. When they close they are adapted to complete a circuit which energizes the stepping magnet SM of the sample counter SC. A pawl on the armature of the stepping magnet SM causes a step-by-step rotation of the ratchet wheel 21 as the magnet is successively energized; and the ratchet wheel 21 is mechanically so connected with the cam disc 22 that the associated contacts 23 are closed at the completion of a predetermined number of energizations of the stepping magnet SM. The closure of the contacts 23 completes a circuit for energizing the release relay R₃ which in operating causes a momentary energization of the release magnet RM, the latter operates to permit a single rotation of the extension shaft 9 upon which the cams CC, CD and CE are mounted.

In the initial movement of rotation of the extension shaft the cam CC operates the associated contacts 24 and 25. The contacts 24 in closing disable the sampler relay SR by short-circuiting the input of the sampler amplifier detector SAD; and the contacts 25 in separating open the energizing circuit of the stepping magnet SM of the sample counter SC and thus suspend the sample counting operation. A moment later in the rotation of the extension shaft the cam CD operates the associated contacts 26 to close a circuit for energizing either the increase magnet IM or the decrease magnet DM, both of which, as previously explained, control the adjustments of the potentiometers P₁, P₂, and P₃. If the relay IR is operated and the relay DR is not, then neither the stepping magnet IM nor the stepping magnet DM is energized by the closure of contacts 26 of cam CD. If neither relay is operated, the increase magnet IM is operated. If both relays are operated, the decrease magnet DM is operated. In the final stage of rotation of the extension shaft 9, the cam CD opens its contacts 26 and immediately thereafter the cam CE momentarily closes its associated contacts 27. The closure of contacts 27 completes a discharge circuit to ground for the large condenser C₂.

When the extension shaft 9 comes to rest at the end of its complete rotation the contact 24 has been opened and the contact 25 closed to permit the resumption of the sampling and sample counting operations, the contacts 26 have been separated to open the path over which one or the other of the magnets DM or IM has been operated, and the contacts 27 have been separated to restore condenser C₂ to the negatively charged condition explained hereinbefore for again registering the number of times that the sampler relay SR operates in the ensuing cycle. Thus a new cycle of sampling and sensitivity adjusting operations is started.

The sampling and sample counting operations are also under the control of relays R₁ and R₂, respectively, the energization of these relays to bring about the suspension of the sampling and sample counting operations being under the control of the sampler disabler SD. The disabler SD is responsive to speech impulses of especially large amplitude which may be present in the speech frequency band with which the sampler disabler SD is connected by way of the band-pass filter BPF₁. The control of the sampler disabler SD over the relays R₁ and R₂ is governed by the sampler disabler disabler SDD which is energized by the transmitting amplifier detector TAD to open the energizing circuit of relays R₁ and R₂ when speech is being transmitted. This arrangement insures that there will be no operation of the

sampler disabler by static when the condition is one where speech is being transmitted instead of being received.

In the operation of the system of Fig. 1, the occurrence of a static impulse of sufficient magnitude in the receiving path acts through the receiving amplifier detector RAD to operate the transmitter disabler TD. If the static impulse occurs in an interval of time immediately preceding the initiation of a word or syllable impulse in the transmitting path equal to the hangover time of the receiving voice-operated chain, the syllable or word impulse upon arrival at the transmitter amplifier detector TAD finds the operating path for the transmitter switch control TSS blocked at the transmitter disabler TD. Therefore the transmission of the word to the transmitting antenna is blocked and the word clipped to an extent that depends upon the particular moment of incidence of the static impulse during the hangover interval immediately preceding the initiation of the voice impulse.

If it is assumed that the hangover time of the voice-operated chain terminating in the transmitting disabler TD is four-hundredths of a second, then the initial portion of the word or syllable may be blocked or clipped by as much as four-hundredths of a second. If it is assumed that the occasional clipping of the word or syllable may be as much as two-hundredths of a second without disturbing effects upon the transmitted speech, then with a hangover time of four-hundredths of a second it is only those static impulses that occur during the second half of this hangover time immediately preceding the initiation of the speech impulse that may cause more than the negligible amount of occasional clipping.

Under the assumed conditions therefore the probability of more than a negligible amount of clipping of the transmitted syllables and words is the probability of static impulses of sufficient amplitude to operate the transmission disabler TD occurring in the voice frequency band of the receiving path in any interval of time two-hundredths of a second long. Therefore the rheostat 16 is adjusted to give a speed of the motor M sufficient to cause the contacts 15 associated with cam CA to cause closures of the controlling circuit of the network TN for a duration of two-hundredths of a second. While the contacts 15 are closed such static energy as may be present in the sampling frequency band in the frequency range determined by the band-pass filter BPF₂ is applied to the sampler amplifier detector SAD and may cause the operation of the sampler relay SR. During the intervals when the contacts 15 are separated the attenuation produced by the network TN effectively blocks the path with respect to the transmission of static energy. Each of the succession of sampling intervals which results in the operation of the sampler relay SR causes the transfer of a large part of the unit charge of the small condenser C₁ to the large condenser C₂, thereby proportionately reducing the bias on the grid of detector D. Consequently, a larger current will flow in the output circuit of the detector D.

In order that the samples may represent long-time effects and not short-time variations in the amount of static energy present, the sampling apparatus is arranged to collect an extended series of samples before the automatic sensitivity adjustment is made. We have found that a cycle including a series of five hundred sampling operations affords a sufficiently accurate long-time

index of the existing static energy condition. Therefore, in the embodiment of the invention that is being described, the sample counter SC is so organized that five hundred steps of the stepping magnet SM, one step for each sampling operation, cause one complete rotation of the cam disc 22, which thereupon closes the associated contacts 23 to bring about the operation of release relay R₃ and release magnet RM to permit the cams CC, CD and CE to make one complete revolution as described hereinbefore.

At the conclusion of a cycle of five hundred sampling operations the sensitivity adjustments are made by the potentiometers P₁, P₂ and P₃. The constants of the detector D and its associated elements are so chosen that when the sampler relay SR has been operated ninety times or less during the cycle of five hundred sampling operations (18% or less of 500 sampling operations), and the potential on the grid of detector D is therefore that which results from the transference of part of the charge of condenser C₁ to condenser C₂ ninety times or less, the current in the plate circuit of the detector D is insufficient to operate either the relay IR or the relay DR. Under these circumstances when contacts 26 of cam CD are closed at the end of the cycle of operations a circuit is completed by way of the back contact of relay IR for the operation of the increase magnet IM, which magnet thereupon causes a one step rotary movement of the shaft bearing the arms of potentiometers P₁, P₂ and P₃ in a direction to increase the sensitivity of the associated devices.

When in the course of a cycle of five hundred sampling operations the sampler relay SR has operated one hundred and twenty-five or more times (25% or more of 500 sampling operations) the potential upon the grid of detector D as a result of one hundred and twenty-five or more transfers of part of the charge of small condenser C₁ is such as to cause a current flow in the output circuit of the detector sufficient to operate both relays IR and DR. Consequently when contacts 26 of cam CD are closed at the end of the cycle a circuit is completed by way of the front contact of relay IR and the front contact of relay DR in series which causes the operation of the decrease magnet DM. This operation causes a one step rotation of the potentiometer arms in a direction such as to decrease the sensitivity of the associated devices.

If in the course of the sampling cycle the sampler relay SR has been operated more than ninety but less than one hundred and twenty-five times (more than 18% but less than 25% of the 500 sampling operations), the potential of the grid of detector D determined by the transfers of more than ninety but less than one hundred and twenty-five portions of the charges of the small condenser C₁ is such as to permit a flow of current in the plate circuit sufficient to operate the relay IR but insufficient to operate the relay DR. Therefore upon the closure of the contacts 26 of cam CD at the end of the cycle the operating path of the increase magnet IM is open at the back contact of the relay IR and the operating path of the decrease magnet DM is open at the front contact of relay DR. Consequently under these conditions, which indicate the probability of a tolerable number of static operations of the sampler relay, and therefore of the equally sensitive receiving voice-operated unit terminating in the transmitter disabler TD, neither the increase magnet IM nor

the decrease magnet DM operates. Thus, the adjustment of the potentiometers P₁, P₂ and P₃ remains unchanged.

During the rotation of the cams CC, CD and CE at the end of the sampling cycle as mentioned hereinbefore, the sampling operation controlled by the contacts 24 and the sample counting operation controlled by the contacts 25 are suspended, and the condenser C₂ is discharged by contacts 27 to place it in readiness for the next succeeding sampling cycle.

As has been pointed out, the static sampling is carried on in a band of frequencies, 3500 to 4700 cycles per second, which is different from the 250 to 2750 cycle band that is used for the received speech frequencies. This permits the sampling operations to proceed continuously even when the circuits are in use for communication. But occasionally the amplitudes of speech energy in the 250 to 2750 cycle speech band are sufficiently great so that harmonics falling in the sampling band of 3500 to 4700 cycles per second are strong enough to cause the operation of the sampler relay SR and thus be falsely recorded as static. To the extent that this occurs the apparent probability indication of static operations in the sampling band is improperly increased and results in an improperly low sensitivity adjustment of the potentiometers.

To prevent such action from taking place in the sampling and sensitivity controlling apparatus there is provided a sampler disabling organization which operates upon the 800 to 2000 cycle portion of the speech frequency band, a 1200 cycle band width equal to the 1200 cycle width of the sampling band. The energizing path of the disabling organization extends from the balanced transformer network BT₁ through the potentiometer P₃, and thence through the band-pass filter BPF₁ to the sampler disabling apparatus SD. The sampler disabling apparatus is normally set so as to be unresponsive to the weaker speech amplitudes, but to respond to those amplitudes which are sufficiently high to produce disturbing harmonic energy in the sampling band. When speech energy of such higher amplitudes is present in the 800 to 2000 cycle portion of the speech frequency band it energizes the sampler disabling apparatus SD to operate the relays R₁ and R₂. The relay R₁ in operating opens the sampling circuit controlled by the contacts 15 of cam CA, and relay R₂ in operating opens the sample counter operating circuit controlled by the contacts 20 of cam CB. Therefore the sampling and sample counting operations are suspended during those intervals when the speech intensities are sufficient to produce false indications of static in the sampling apparatus.

The sampler disabling organization which has just been described may under certain circumstances itself tend to cause improper response of the sampling and sensitivity adjusting apparatus. Under conditions of heavy static the static energy may also appear in the sampler disabling circuit at sufficiently high amplitudes so that the disabler SD is operated not only by the high amplitude speech energies, but also by the static impulses which reach it through the band-pass filter BPF₁. The result is that static in the disabler path operates the relays R₁ and R₂ to suspend the sampling and sample counting operations in the same manner as does the high intensity speech energy. Inasmuch as the condition is one where heavy static is also probably

simultaneously occurring in the sampling band the effect of the operation of the disabler by static is to simultaneously make the sampler relay SR non-responsive to the static in the sampling band and therefore tend to reduce the number of static operations registered in the circuit of detector D. This leads under conditions of heavy static to an automatic potentiometer adjustment resulting in an unwarrantedly high sensitivity in the devices which the potentiometers control.

This improper operation is prevented in Fig. 1 by so arranging the potentiometer P₃ which controls the sensitivity of the sampler disabling branch that it does not act to insert loss in or diminish the sensitivity of the branch which it controls until the static energy reaches a predetermined level. When this level is reached the potentiometer P₃ introduces attenuation into the sampler disabler branch to the extent necessary to prevent any such operation of the sampler disabling apparatus SD by static as would affect the proper relationship between the static energy levels in the sampling band and the speech band and the appropriate potentiometer adjustments corresponding to these levels.

As the statistical distribution of static energy in the sampling frequency band is the same as in the portion of the speech frequency band over which the receiving amplifier detector RAD and the associated transmitting disabler TD are operated, and as the sampler apparatus terminating in the sampler relay SR and the receiving amplifier detector apparatus terminating in the transmission disabler TD are adjusted to have the same sensitivities, it follows that the percentage ratio of static operations of the sampler relay SR during an extended series of two-hundredths of a second intervals to the total number of sampling tests is substantially the probability ratio of operation of the transmitting disabler TD in the two-hundredths of a second interval. The latter intervals as mentioned hereinbefore represent the difference between the total hangover time of four-hundredths of a second and the negligible clipping time of two-hundredths of a second. The percentage limits of tolerable static operations of sampler relay SR and transmitter disabler TD as hereinbefore set forth are arbitrarily chosen; but experience indicates that they are reasonable limits. They correspond to the percentage of words or syllables that may be initially clipped by more than two-hundredths of a second without making the speech uncommercial.

If the conditions in the radio terminal to which the invention is to be applied are such as to suggest a different criterion with respect to the percentage of clipping permissible, this criterion may readily be employed by adjusting the sensitivity of the relays IR and DR or by varying the constants of the detector D and its related elements. Similarly the length of the sampling intervals may be varied as desired, by changing the speed of the motor M to correspond with variations in the hangover time of the chain of elements in the receiving voice-operated device.

Operation of Figs. 2 and 3

Reference has been made in the description of Fig. 1 to the occurrence in the sampling band of harmonics of high amplitude speech energy present in the speech band, and to the manner in which the sampler may be disabled to prevent false operations when this condition occurs. Figs.

2 and 3 illustrate a modification in which a sampler disabling circuit is provided that prevents false operations of the sampling apparatus by high speech energy amplitudes in the speech band, and at the same time prevents the operation of the disabling apparatus by static crashes occurring simultaneously in the sampling band and in the speech band.

Fig. 2 shows a circuit arrangement which is generally similar to that illustrated in Fig. 1 except that the potentiometer P₃ is omitted. The principal difference lies in the sampler disabling circuit. This circuit is a differential or balanced circuit in which rectified energy derived from a portion of the speech frequency band is balanced against rectified energy derived from the sampling frequency band. Referring to Fig. 2, a branch of the receiving path is connected by way of balanced transformer network BT₁ with band-pass filter BPF₁ adapted to pass frequencies between 800 and 2000 cycles per second and band-pass filter BPF₂ adapted to pass frequencies between 3500 and 4700 cycles per second. The frequencies passed by the first mentioned filter constitute a part of the frequency range of the speech band, and the frequencies passed by the second mentioned filter constitute the sampling frequency band. The output of the filter BPF₂ is connected by way of the transformer network BT₂ with two branches, one of which extends by way of the sensitivity adjusting potentiometer P₁ to the sampling apparatus, and the other of which extends by way of the variable gain device VG to the high band amplifier HBA. The output of the band-pass filter BPF₁ is connected to the low band amplifier LBA. The output energies of the low band amplifier LBA and the high band amplifier HBA are rectified in the low band rectifier LBR and the high band rectifier HBR respectively, and are applied to the differential circuit DC. This differential or balanced circuit is connected with the input of the differential amplifier DA, the output of which is connected with the differential relay R₄. This relay in its operation controls the operation of the disabling relay R₅. The disabling relay R₅ performs the same function that is performed in Fig. 1 by the relays R₁ and R₂; that is, when it is operated it causes a suspension of the sampling and sample counting operations of the sampler apparatus.

The sampling, counting, and potentiometer adjusting organizations of the system of Fig. 2 may be assumed to be substantially the same as those of the system of Fig. 1 and therefore include the various elements constituting the organization for performing the counting and sampling operations, summing up the static operations and applying the result to the adjustment of the potentiometers P₁ and P₂. In Fig. 2, these elements are generally shown in the box designated sampler and counter.

Fig. 3 shows in detail the balancing circuit for controlling the operation of the disabling circuit embodying the disabling relay R₅. The low band frequencies, between 800 cycles and 2000 cycles per second, reach the input of the low band amplifier LBA by way of transformer 28; and the high band frequencies, between 3500 cycles and 4700 cycles per second, reach the high band amplifier HBA by way of the transformer 29. The amplifiers are preferably of a type known commercially as Western Electric 262—A. The outputs of low band amplifier LBA and high band amplifier HBA are coupled by means of transformers 30 and 31 with a low band thermionic

rectifier LBR and high band thermionic rectifier HBR, respectively. The rectifiers are preferably of a type known commercially as Western Electric 272—A.

Included in the circuit of these rectifiers are the biasing batteries 32, the voltages of which are so chosen that no current flows in either rectifier circuit normally, and none is permitted to flow until the half-wave potential impressed by way of the associated transformer exceeds the biasing potential of the associated battery 32. Each of the rectifiers LBR and HBR includes in its circuit a high resistance, 33 and 34 respectively, and these high resistances are included in series relation with each other and with the high resistances 35 and 36. The junction of resistances 34 and 36 is connected by way of high resistance 38 with the grid of the thermionic tube 40 of the differential amplifier DA, and the junction of resistances 33 and 35 is connected by way of high resistance 37 with the grid of the thermionic tube 39 of the differential amplifier DA. A negative biasing potential is applied to the grids of both tubes by battery 41. The tubes 39 and 40 are preferably of a type known commercially as Western Electric 271—A.

The output of tube 40 includes a plate current equalizer E and one winding of the differential relay R₄, and the output of tube 39 includes another winding of the differential relay R₄. The differential relay has a third winding, in which the current flow serves to bias the relay in a direction to cause it to hold its armature against its normal or resting contact.

The differential relay R₄ controls the disabling relay R₅. The relay R₅ is normally biased by one of its windings to hold its armature against its normal or resting contact. When the differential relay R₄ operates, the opening of its resting contact removes a shunt from and increases the current flow in the lower winding of the disabling relay R₅; and an instant later the closing of the front contact of differential relay R₄ closes the energizing circuit of the upper winding of the disabling relay R₅. The effect of the current flow in both of these windings is in opposition to the effect produced by the biasing winding. The relay R₅ operates when the armature of relay R₄ leaves its resting contact, and the energizing effect is increased when the relay R₄ closes its front contact.

The manner in which the system of Fig. 2 provided with the balanced or differential sampling disabler circuit of Fig. 3 operates is as follows: Ordinary amplitudes of speech energy in the 250 to 2750 cycle speech bands are insufficient to disable and suspend the sampling operation, for the reason that these energies are insufficient (referring to Fig. 3) to impress upon the low band rectifier LBR voltages high enough to overcome the biasing voltage produced by the biasing battery 32 in the circuit of this rectifier. Furthermore, the effects of normal or average speech amplitudes in the portion of the speech frequency band which is in operative relation with the low band amplifier LBA and the low band rectifier LBR may also be controlled with respect to any possible disabling effect by the biasing and adjustment of the differential relay R₄.

But when the amplitudes of speech energy are sufficiently great so that the harmonics falling in the sampling band may cause the operation of the sampler relay and thus be falsely recorded as static, these amplitudes cause differential relay R₄ to operate and, in turn, to operate disabling

relay R₅ to suspend the sampling operation. When such amplitudes of speech energy occur in the portion of the speech band connected with low band amplifier LBA, they generate voltages in the circuit of low band rectifier LBR that are sufficient to overcome the voltage of the associated polarizing battery 32. Consequently a rectified current flows which causes a potential drop across the terminals of the associated high resistance 33. The direction of this rectified current is such as to make the upper terminal of the resistance 33 positive and the lower terminal negative. This potential is applied to the circuit including resistances 34, 36 and 35, the result being to make the grid of tube 40 less negative and the grid of tube 39 more negative than normal.

Under normal conditions the currents flowing in the plate circuits of tubes 39 and 40 are equal, any normal inequality being equalized by the adjustment of plate current equalizer E. As the energizing effects of normal plate current flow in differential relay R₄ are balanced by the opposed relation of the two windings, indicated by the opposition of the small arrows, relay R₄ is normally energized by its biasing winding only, in a direction to hold its armature against the associated resting contact. But when the grid of tube 39 goes more negative and that of tube 40 goes less negative as a result of the high amplitude of voice energy in the speech band, the balance in relay R₄ is overcome by the increased current flow in the upper winding and the decreased current flow in the lower winding, and when this unbalance becomes great enough to overcome the effect of the biasing winding the relay operates. Therefore the disabling relay R₅ is operated and the sampling operation is suspended by the presence in the speech band of speech energy of sufficient amplitude to produce disturbing effects in the sampling band. Such harmonics as this relatively large low band energy produces in the high band are of a reduced magnitude and are insufficient to cause any rectified current flow in the circuit of the high band rectifier HBR (Fig. 3); and as a result there is no electromotive force set up across the high resistance 34 in opposition to that set up, as described, across the high resistance 33.

But let it be assumed that there is a static crash which falls equally in the portion of the speech frequency band connected with the low band amplifier LBA and in the sampling band connected with high band amplifier HBA. The result will be the production of a potential across the terminals of high resistance 34 associated with the high band rectifier HBR equal and opposite to that produced across high resistance 33 associated with low band rectifier LBR. The result therefore is to nullify the effect upon the differential amplifier DA which otherwise would be produced by the static crash in the low frequency band. Therefore the differential relay R₄ is not operated and the disabling relay R₅ remains inert and permits the sampling apparatus to respond to the static crash which otherwise would go unrecorded.

In practice the sensitivity of the high band of the differential circuit to static is made equal to or slightly greater than that of the low band, so that if the static energy in the two bands is equal the disabler will not operate. The sensitivity adjustment may conveniently be made through the medium of the variable gain device VG (Fig. 2) and by the proper biasing and adjustment of the differential relay R₄. Occasionally the energy amplitude of a static crash may be sufficiently

greater in the low band than in the high band so as to cause an operation of the adjustable relay R_s . But tests have indicated that such disabling operation on static in the low band is so infrequent as to be negligible in its effect upon the proper operation of the automatic sensitivity adjusting apparatus.

Operation of Fig. 4

Fig. 4 shows a circuit arrangement which is substantially identical with that of Fig. 2. The principal difference lies in the fact that Fig. 4 is a three-band system while Fig. 2 is a two-band system. That is, in Fig. 2, the differential circuit balances rectified energy derived from the speech frequency band against rectified energy drawn from the sampling frequency band whereas in Fig. 4 the differential circuit balances rectified energy derived from the speech frequency band against rectified energy drawn from a frequency band intermediate the speech and sampling frequency bands. Therefore, in Fig. 4, the disabling and balancing circuits are operated in frequency bands that are independent of the sampling frequency band. Thus, in Fig. 4, the sampling takes place at random with respect to the disabling and balancing circuits.

Referring to Fig. 4, a branch of the receiving path is connected by way of balanced transformer network BT_1 with band-pass filter BPF_4 adapted to pass frequencies between 900 and 1500 cycles per second, and balanced transformer network BT_2 . The latter is connected to band-pass filter BPF_5 adapted to pass frequencies between 3400 and 4000 cycles per second and BPF_6 adapted to pass frequencies between 4200 and 4800 cycles per second. The frequencies passed by BPF_4 constitute a range lying in the speech frequency band; the frequencies passed by BPF_5 constitute a range intermediate speech and sampling bands for balancing against the speech frequency range of BPF_4 in the differential circuit; and the frequencies passed by BPF_6 constitute the sampling frequency band.

The outputs of BPF_4 and BPF_5 are connected to the low band amplifier LBA and high band amplifier HBA , respectively, both of which are incorporated in the differential circuit. The disabling and the balancing circuit are identical with the same apparatus explained above in connection with Fig. 2. The sampling and potentiometer adjusting organizations are substantially the same as those of the system shown in Figs. 1 and 2, and include the various elements comprising the organization for performing the counting and sampling operations, aggregating the static operations and applying the result for effecting the adjustments of the potentiometers P_1 and P_2 . The potentiometer P_3 of Fig. 1 is of course omitted in Fig. 4. The differential circuit for controlling the functioning of the disabling relay R_s is shown and described in detail in Fig. 3.

The low band frequencies between 900 and 1500 cycles per second are impressed on LBA ; the intermediate band frequencies between 3400 and 4000 cycles per second are applied to HBA ; and the high band frequencies between 4200 and 4800 per second are passed by BPF_6 . Inasmuch as BPF_4 and BPF_5 are directly connected to the differential circuit, the static energy balanced therein controls the operation of the disabling relay R_s . At the same time, the static energy passing through BPF_6 effects the operation of the sampler without regard to the static energy passing through BPF_4 and BPF_5 .

Thus, static falling in any one band is independent of static falling in the other two bands; and obviously, static falling in the balancing band including BPF_4 and BPF_5 is entirely independent of static falling in the sampling band including BPF_6 . Therefore, the disabling due to energy in BPF_4 and BPF_5 will not affect the sampling due to energy in BPF_6 , and vice versa. Hence, the disabling will be accomplished independently of the static energy passing through BPF_6 , and the sampling will be accumulated without regard to the static energy passing through BPF_4 and BPF_5 .

Thus, the sampling is entirely at random with respect to the disabling and balancing circuits. That is, the disabling and balancing are being carried on irrespective of what is taking place in the sampling band. It may be said also that the disabling and balancing are at random with regard to sampling since the former proceed independently of what is happening in sampling circuit.

What is claimed is:

1. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, means for adjusting in equal amounts the sensitivity of the voice-operated means connected to the receiving path, and means connected to the receiving path in a predetermined number of alternately effective and non-effective intervals and operatively responsive during effective intervals to indicate energy of at least a certain level in the receiving path and during ineffective intervals to aggregate the indications and to actuate the adjusting means to effect a sensitivity adjustment depending on the ratio of the aggregate of the indications to the predetermined number of effective intervals.

2. A two-way signaling system according to claim 1 in which the sensitivity of the voice-operated means connected to the receiving path remains unchanged when the ratio falls within a predetermined range; the sensitivity is increased when the ratio is below the predetermined range; and the sensitivity is decreased when the ratio is above the predetermined range.

3. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, means for adjusting in equal amounts the sensitivity of the voice-operated means connected to the receiving path, means for collecting indications of energy of at least a certain level in the receiving path, and means for providing a predetermined number of time intervals during which the indications are collected, the adjusting means being controlled by the collecting means so as to provide a sensitivity depending on the ratio of the collected indications to the predetermined number of collecting intervals.

4. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, means for col-

lecting indications of energy of at least a certain level in the receiving path, means for adjusting in equal amounts the sensitivity of the voice-operated means connected to the receiving path and the collecting means, means for providing a predetermined number of time intervals during which the indications are collected, and means controlled by the collecting means to actuate the adjusting means to provide a sensitivity depending on the ratio of the collected indications to the predetermined number of collecting intervals.

5. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, observing means connected to the receiving path, means for adjusting in equal amounts the sensitivity of the voice-operated means connected to the receiving path and the observing means, means for rendering the observing means operative a predetermined number of time intervals, electromagnetic means connected to the observing means and operatively responsive during the operative time intervals thereof to indicate static of at least a certain level, and means for aggregating the operations of the electromagnetic means so as to actuate the adjusting means to provide a sensitivity depending on the ratio of the aggregate of the operations to the predetermined number of time intervals.

6. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, observing means connected to the receiving path, means for increasing the sensitivity of the voice-operated means connected to the receiving path and the observing means, means for decreasing the sensitivity of the voice-operated means connected to the receiving path and the observing means, means for rendering the observing means operative a predetermined number of time intervals, electromagnetic means connected to the observing means and operatively responsive to static of at least a certain level during the operative intervals thereof, a thermionic detector having a predetermined grid bias, means controlled by the operations of the electromagnetic means for decreasing the bias to increase the output current of the detector, and two electromagnets of different sensitivities connected in the output of the detector, the electromagnets being operated singly and in combination to select the increasing means and the decreasing means depending on the level of the output current of the detector.

7. A two-way signaling system according to claim 5 which includes means to disable the means for rendering the observing means operative when transmission in the receiving path attains a predetermined level.

8. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, observing means connected to the receiving path, means for increasing the sensitivity of the voice-operated

means connected to the receiving path and the observing means, means for decreasing the sensitivity of the voice-operated means connected to the receiving path and the observing means, means for rendering the observing means operative a predetermined number of time intervals, a three-element thermionic tube having a control grid, a battery for biasing the control grid, a relatively large capacity connected to the control grid, a relatively small capacity, a battery for providing the small capacity with a positive charge, electromagnetic means operatively responsive during the operative time intervals of the observing means to transfer a portion of the positive charge on the small capacity to the large capacity, the accumulation of the portions of positive charges on the large capacity tending to make the control grid less negative thereby increasing the current flow in the output of the tube, and two electromagnets of different sensitivities connected in the output of the tubes, the electromagnets being operated singly and in combination to select the increasing means and decreasing means depending on the magnitude of the current in the output of the tube.

9. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, a filter connected to the receiving path for passing static energy above the frequency range of speech transmission, a filter connected to the receiving path for passing static energy in the frequency range of speech transmission, means connected to the first-mentioned filter for collecting indications of static energy of at least a certain level, means for increasing the sensitivity of the collecting means and the voice-operated means connected to the receiving path, means for decreasing the sensitivity of the collecting means and the voice-operated means connected to the receiving path, means for providing a predetermined number of time intervals during which the indications are collected, means controlled by the collecting means to select the increasing means and the decreasing means to provide a sensitivity depending on the ratio of the collected indications to the predetermined number of collecting intervals, means connected to both filters to balance the energy of one against that of the other, and means connected to the output of the balancing means and operated when the static energy passed by the second-mentioned filter is of a higher level than that passed by the first-mentioned filter, thereby disabling the means for providing the predetermined number of time intervals.

10. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, a filter connected to the receiving path for passing static energy above the frequency range of speech transmission, a filter connected to the receiving path for passing static energy in the frequency range of voice transmission, observing means connected to the first-mentioned filter, means for increasing the sensitivity of the observing means and the voice-operated means connected to the

receiving path, means for decreasing the sensitivity of the observing means, and the voice-operated means connected to the receiving path, means for rendering the observing means operative a predetermined number of time intervals, electromagnetic means connected to the observing means and operatively responsive to static of at least a certain level during the operate intervals thereof, a thermionic detector having a predetermined grid bias, means controlled by the operation of the electromagnetic means for decreasing the bias to increase the output of the detector, two electromagnets of different sensitivities connected in the output of the detector, the electromagnets being operated singly and in combination to select the increasing means and the decreasing means to provide a sensitivity depending on the level of the output current of the detector, means connected to both filters to balance the energy of the one against that of the other, and means connected to the output of the balancing means and operated when the static energy passed by the second-mentioned filter is of a higher level than that passed by the first-mentioned filter, thereby disabling the means for providing the predetermined number of operative time intervals of the observing means.

11. A two-way signaling system according to claim 10 in which an intermediate filter is connected to the receiving path to pass static energy above the frequency range of voice transmission but below the frequency range of the filter pass-

ing energy above the range of voice frequency, means is connected to the filter passing static in the frequency range of voice transmission and the intermediate filter to balance the energy of one against that of the other, and means is connected to the output of the balancing means and operated when the static energy in the filter passing energy in the voice frequency range is of a higher level than that passed by the intermediate filter, thereby disabling the means for providing the predetermined number of operative time intervals of the observing means.

12. In a two-way telephone system having one path adapted for transmission in a transmitting direction and the other path adapted for transmission in a receiving direction, and voice-operated means connected to each path for preventing transmission over the one path while transmission is being effected over the other, the method of adjusting the sensitivity of the voice-operated means connected to the receiving path which comprises providing a predetermined number of time intervals for observing static energy in the receiving path, collecting indications of static energy relative to a certain level during the observing intervals, and utilizing the ratio of the number of collected indications to the predetermined number of observing intervals for effecting the sensitivity adjustment in equal amounts.

BJÖRN G. BJÖRNSON.
NEWTON W. BRYANT.