

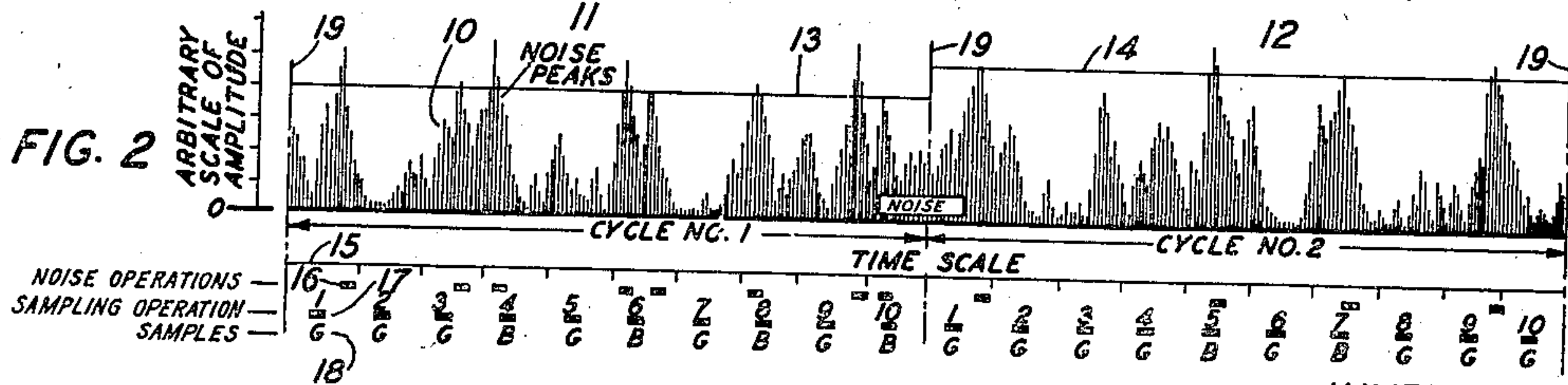
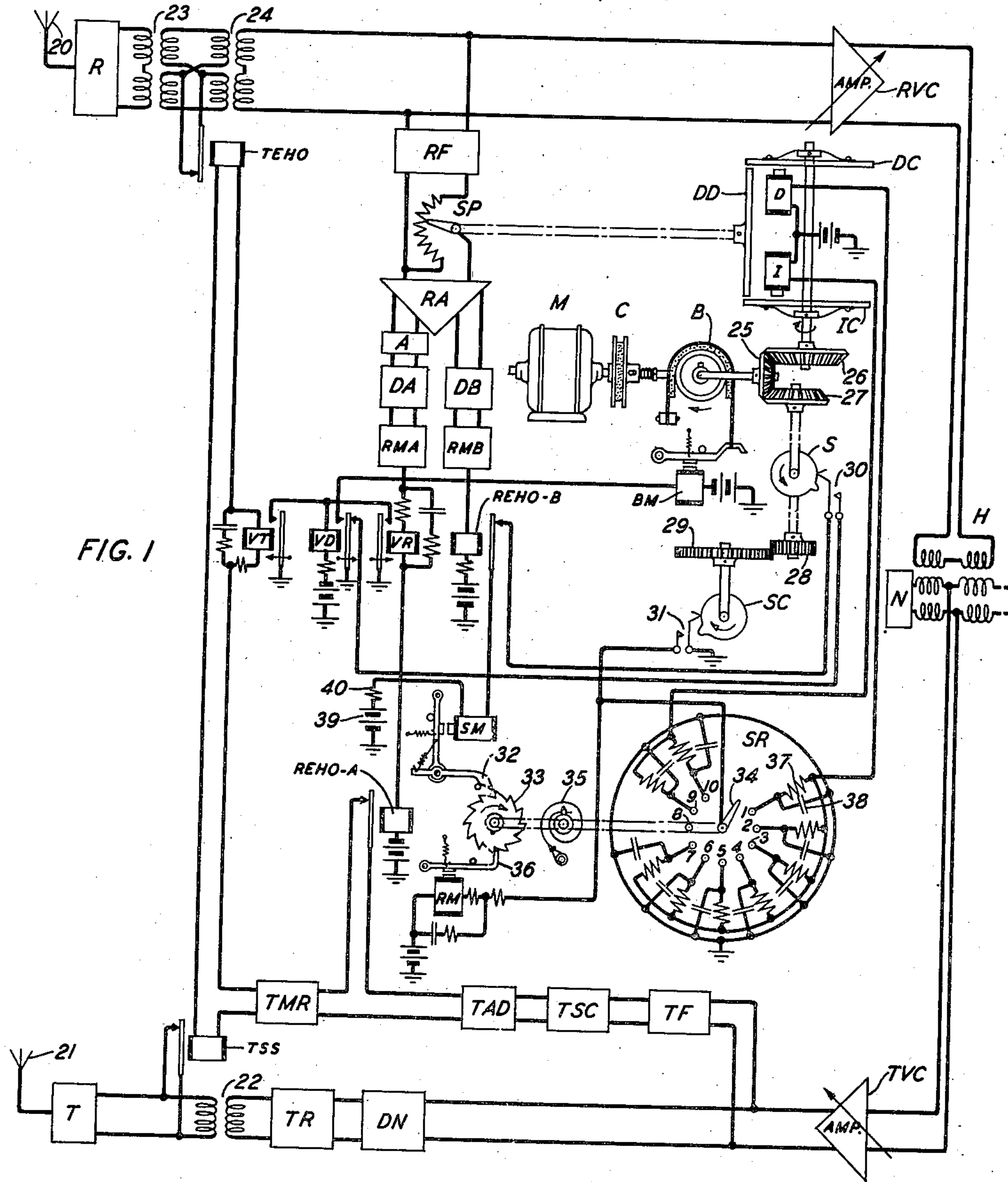
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TWO-WAY SIGNALING SYSTEM

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TWO-WAY SIGNALING SYSTEM

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This invention relates to two-way signaling systems and particularly to the 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 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
15 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 re-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 echoe 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
30 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.

40 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
45 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
50 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
55 from two one-hundredths to five 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
5 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.

10 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
15 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 lesser degree, and the static
20 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
25 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 equal to the hangover time of the receiving voice-operated device. Under
30 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
35 so that the number of false operations is reduced.

Heretofore the need for such sensitivity adjustments has generally been met in practice by having a technical operator make such adjustments manually. In making the adjustments the
40 technical operator has been guided by the visual indication of a meter controlled 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
45 speech. It has been found that when the adjustments are thus made manually, the tendency is to make the sensitivity of the receiving voice-operated device unnecessarily low; and as this
50 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 transmitter through the hybrid coil, it results in the delivery of an unnecessarily low
55 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 re- 60

lation 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, and a predetermined tolerable number of such operations. Tests show that a certain number of noise operations, resulting in false operations of the receiving voice-operated device, can be tolerated without serious degradation of the quality of the transmitted speech.

In accordance with this invention apparatus is provided which counts the number of noise operations during a cycle including a predetermined number of short testing or sampling intervals, and then increases or decreases the sensitivity by an amount designed to compensate for the difference between the number of operations observed during the testing cycle and a predetermined tolerable number of such operations. The percentage ratios of good sample, or samples during which no static or noise operation occurs, to the total number of samples collected is automatically determined. If the percentage ratio of good samples to the total number collected falls below the predetermined tolerable percentage, that is, if the percentage of bad samples and consequent false operations is too great, the sensitivity of the receiving voice-operated device and of the sample collecting path is automatically reduced. If the ratio of the good samples to the total number of samples collected is greater than the predetermined tolerable ratio, then the sensitivity of the receiving voice-operated device and of the sampling path is automatically increased. Thus, the adjusting mechanism operates to keep the sensitivity of the receiving voice-operated device automatically adjusted to the maximum sensitivity consistent with unmutated speech transmission for the changing conditions of static which prevail from time to time. In the preferred embodiment of the invention means are provided which permit the testing or sampling process to continue only when speech is not present in either side of the communicating circuit.

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 drawing, in which:

Figure 1 is a diagrammatic representation of one terminal of a four-wire telephone transmission circuit equipped with a voice-operated device for adjusting sensitivity in accordance with the principles of this invention; and

Fig. 2 is a graph illustrating an example of how the voice-operated device for adjusting sensitivity would operate on an assumed static noise.

Referring first to Fig. 2, the noise, indicated by a series of vertical lines 10 of widely varying heights to illustrate the varying noise intensities, is shown plotted against arbitrary time and amplitude scales. This series is divided into two sections 11 and 12 which represent two measuring cycles of the automatic sensitivity adjusting apparatus. Parallel with the base line are two lines 13 and 14 at different levels, which represent the sensitivity of the relay of the automatic adjusting apparatus which is energized by the noise or static impulses. The lower level of line 13 represents greater sensitivity of the relay, and the higher level of the line 14 represents a less degree of sensitivity of the relay. Where the intensity of the noise is sufficient to carry the vertical line representing it above the horizontal line representing relay sensitivity, the relay is operated.

The line 15 below and parallel with the base line of the noise chart indicates an arbitrary time scale. Below this are two horizontally extending series of dashes 16 and 17, the upper one of which represents operations of the relay of the automatic adjusting device, and the lower one of which represents an extended series of regularly recurring testing or sampling intervals. It will be observed that the position of each of the series of dashes in line 16 corresponds with positions of the points on the relay sensitivity lines 13 and 14 where the intensity of the noise or static rises above the level of the sensitivity line and consequently causes the operation of the relay. Where the position of a testing or sampling interval of the series 17 does not coincide with the interval of relay operation represented on line 16, the sample is good. Where there is a coincidence in position between the sampling interval of the series 17 and the relay operating interval of the series 16, the sample is bad. The coincidence or lack of coincidence for each sampling interval is indicated by the letter "B" for bad or "G" for good in line 18.

Referring now to the testing cycle represented in section 11 of the chart, it will be observed that the first three of the testing intervals do not coincide with the interval of relay operation by static, and therefore these three samples are good. The fourth testing interval of the series coincides with a static-operated condition of the relay and therefore the sample is bad. Comparing the positions of the ten equally spaced testing intervals of the first test cycle shown in line 17 with the positions indicating relay operated condition shown in line 16, it will be seen that there is non-coincidence in six cases and coincidence in four cases. Therefore, as indicated in line 18, the result of the first testing cycle is the collection of six good samples and four bad samples.

If it is assumed that not more than two bad samples or false operations of the relay should be tolerated, the first testing cycle indicates that the sensitivity of the relay is too high and should be reduced. This reduction of sensitivity is indicated by the altered level of the line 14 in the second cycle. In this cycle, with generally the same type of static, it will be seen that there are only two cases of coincidence between the series of testing intervals represented in line 17 and the series of relay-operated intervals represented in line 16. Therefore, the sensitivity adjustment of the relay has resulted in the reduction of the noise operations to a tolerable number.

Fig. 1 illustrates the manner in which the present invention may be applied for use 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 conjugate transformer H provided with the usual balancing network N. One of the two paths of the four-wire portion of the circuit extends from the hybrid coil to the receiving antenna 20 and the other path extends from the hybrid coil to the transmitting antenna 21. 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 volume control de-

vice RVC, and included in the transmitting branch is the transmitting volume control device TVC. Also included in the transmitting branch are the delay network DN and the transmitting repeater TR with a normally closed short circuit controlled in resting contacts of the transmitting short-circuiting relay TSS connected across the secondary winding of the transformer 22 associated with the transmitting repeater TR. These elements are part of the customary anti-singing arrangement of the transmitting voice-operated device.

The branch of the transmitting path extending from a point between the transmitting volume control TVC and the delay network DN is the customary path over which the transmitting echo hangover relay TEHO and the transmitting singing suppressor relay TSS are controlled by the passage of speech over the transmitting path of the circuit. This voice-controlled branch includes the transmitting frequency weighting network TF, the transmitting sensitivity control TSC, the transmitting amplifier-detector TAD, and the transmitting master relay TMR. The continuity of this transmitting voice-controlled path is controlled in the normally resting contacts of the receiving echo hangover relay REHO—A.

Included in the receiving path are the transformers 23 and 24 so arranged that one winding of each is under the control of the resting contact of the transmitting echo hangover relay TEHO. Between the secondary winding of the transformer 24 and the receiving volume control device RVC is connected the branch of the receiving path which controls the customary receiving voice-operated device including the echo hangover relay REHO—A and also controls the sampling voice-operated device including the relay REHO—B that responds to the noise or static impulses and cooperates in the control of the sampling and automatic sensitivity-adjusting apparatus.

The above mentioned branch from the receiving path includes a frequency-weighting network RF which, in this particular example, may be a band pass filter adjusted to pass a band of frequencies lying between 800 and 2000 cycles per second. The output of the frequency weighting network RF is connected with the input of the receiving amplifier RA through a sensitivity controlling potentiometer SP. Connected with the output of the amplifier RA are two branches one of which extends through the attenuator A and detector DA to the receiving master relay RMA and the other of which is connected directly through the detector DB to the receiving master relay RMB.

The receiving master relay RMA in its operation controls a path that extends through the receiving voice controlled relay VR and the receiving echo hangover relay REHO—A, while the receiving master relay RMB in its operation controls a path that includes the sampler controlling relay REHO—B. By means of the attenuator A and the adjustment of the master relays RMA and RMB the path which brings about the operation of the receiving echo hangover relay REHO—A is made less sensitive than the path over which the receiving echo hangover relay REHO—B is operated. The relative sensitivities of these two paths, as will hereinafter be explained, are made such that the relay REHO—A will be operated by speech and only occasionally by static, whereas the relay REHO—B will be operated by static as well as by speech. The sensitivity of both of these paths, one of which remains normally more

sensitive than the other, is controlled by the common sensitivity controlling potentiometer SP. The potentiometer SP is motor driven, and is the instrumentality through which the automatic sensitivity control is effected.

Referring now more particularly to the part of the organization through which the automatic sensitivity control is effected in the particular embodiment of the invention illustrated, there is provided a motor M the shaft of which drives a bevelled gear 25 through the medium of a clutch member C which is adjusted so as to slip and permit the bevelled gear 25 to come to rest when the band of the brake B is tightened upon the associated brake drum. The tightening of the brake band upon its drum occurs when the brake magnet BM is energized to attract its armature.

Two gears 26 and 27 are driven by the bevelled gear 25. The shaft to which the bevelled gear 26 is fixed carries the two clutch discs DC and IC. These two discs are so connected with the shaft that they are rotationally rigid upon it, but are capable of being tilted into clutching engagement with diametrically opposite points upon the associated driven disc DD when attracted by their respective magnets D and I. The other end of the shaft to which the driven disc DD is fixed carries the contact arm of the sensitivity controlling potentiometer SP. When the magnet D is energized to cause the disc DC to engage the driven disc DD, the potentiometer arm is moved in a counterclockwise direction as viewed in the drawing to decrease the gain of receiving amplifier RA and therefore the sensitivity relay RMB. When the magnet I is energized to cause disc IC to engage the driven disc DD, the potentiometer arm is moved in a clockwise direction to increase the gain of the receiving amplifier RA and therefore the sensitivity of relay RMA.

The lower bevelled gear 27 driven by the bevelled gear 25 is fixed to a shaft upon which is mounted the sampling impulse cam S, and upon which is also mounted a pinion 28 meshing with a gear 29 which drives the sample counting cam SC. The sampling impulse cam S causes the closure of the contacts 30 once for each revolution of the cam. Similarly the contacts 31 are closed once for each revolution of the sample counting cam SC. The ratio of the gears 28 and 29 is so chosen that for each closure of the contacts 31 the contacts 30 are closed any desired number of times. The length of the testing cycle is controlled by the cam SC, and the number and duration of the separate tests or sampling operations per cycle is controlled by the cam S.

The contacts 30 of the sampling cam S and the resting contacts of the relay REHO—B cooperate in the control of the stepping magnet SM. Each time the stepping magnet SM is energized it actuates the pawl 32 to engage the ratchet wheel 33 and cause the switch arm 34 of the sample recorder SR to advance one step against the tension of the restoring spring 35. The advance of the ratchet wheel is retained by the retaining pawl 36 subject to the control of the release magnet RM. The arm 34 of the sample recorder normally rests upon a dead contact point. In the particular embodiment illustrated, the first seven contact points lying beyond the dead contact point are connected with the magnet D the energization of which operates the potentiometer SP to decrease the sensitivity of the receiving amplifier RA and its branches. The eighth contact point of the sample recorder SR is a dead contact point. The ninth and tenth contact points are

connected with the magnet I the energization of which causes the movement of the switch arm of the potentiometer SP in such a direction as to bring about an increase in the sensitivity of the receiving amplifier RA and its associated branches. Each of the contacts of the sample recorder SR is connected to its associated magnet D or I through a resistance 37; and each of the contact points has connection with one plate of a condenser 33 the other plate of which is connected to ground. These resistances and condensers, as will hereinafter be explained, are for the purpose of controlling the duration of operation of the magnets D and I to govern the extent to which the arm of the potentiometer SP is moved in one direction or the other to control the gain of the receiving amplifier RA.

The contacts 31 closed by the sample counting cam SC once per revolution complete a circuit that energizes the arm 34 of the sample recorder SR to operate either the sensitivity decrease magnet D or the sensitivity increase magnet I, depending upon the position of the arm 34 when the contacts 31 are closed. They also govern the energization of the release magnet RM to move the retaining pawl 36 and permit the restoration to normal of the sample recorder SR.

The disabling relay VD, under the control of the receiving voice-controlled relay VR and the transmitting voice-controlled relay VT, acts to disable the sampling apparatus and interrupt the sampling operation by virtue of its control over the brake magnet BM. When the relay VD operates it energizes the brake magnet BM, which tightens the band on the brake B and stops the rotation of the driving gear 25 and its associated driven gears 26 and 27. Both the transmitting voice-controlled relay VT and the receiving voice-controlled relay VR are made slow to operate by their associated timing networks. The disabling relay VD is so adjusted as to be slow to release.

The ability of the subscriber to impress speech or voice impulses upon the transmitting antenna 21, assuming the voice currents to be of sufficient magnitude, depends upon the operated or non-operated condition of the receiving echo hangover relay REHO—A. The path to the transmitting apparatus T is normally disabled by the short circuit existing in the resting contacts of relay TSS. When the receiving echo hangover relay REHO—A is not operated, the voice impulses pass from the hybrid coil H by way of the transmitting volume control device TVC, and thence into the branch including the transmitting frequency weighting network or filter TF, the transmitting sensitivity control TSC, and the transmitting amplifier detector TAD to the transmitting master relay TMR. When the master relay TMR operates it operates the transmitter short-circuiting relay TSS to open its short circuit contacts and thus remove the normal disability from the transmitting path. On account of the delay introduced in the propagation of the voice impulses in the talking path by the delay network DN, the normal short circuit of the transmitting path is opened by the relay TSS ahead of the arrival of the voice impulse over the talking path through the delay network DN and the transmitting repeater TR.

The transmitting master relay TMR also causes the operation of the relay VT and the transmitting echo hangover relay TEHO. The latter relay in opening its resting contacts changes the interconnected windings of the transformers 23—24 from a series aiding relation to an opposing rela-

tion, thus introducing a high attenuation into and disabling the receiving path. The arrangement employed is that which is disclosed and described in Patent 1,749,841 to H. C. Silent issued March 11, 1930. Thus the application of voice impulses to the transmitting path when the receiving echo hangover relay REHO—A is not operated causes the removal of the normal disability from the transmitting path and introduces high attenuation into and disables the receiving path. But if the receiving echo hangover relay REHO—A is operated the transmitting impulses cannot operate the transmitting master relay TMR to clear the transmitting path and disable the receiving path.

The proper and intended operation of the receiving echo hangover relay is that which is brought about by the presence of speech or voice impulses in the receiving path of the communicating circuit. But the relay may also be operated by static or noise impulses in the receiving path; and such false operations, by preventing the speech in the transmitting branch from clearing the path to the transmitting antenna 21 by the operation of the relay TSS, may cause the clipping or elimination of syllables and consequent mutilation of the speech. It is, therefore, desirable to maintain an adjustment of the responsiveness of the relay REHO—A to static or noise impulses that will minimize its false operations; and this is accomplished by the operation of the sampling and automatic sensitivity adjusting apparatus of this invention the operation of which will now be described.

Received speech with the accompanying static passes from the receiving antenna 20 through the receiving apparatus R, the transformer network 23—24, normally in a non-attenuating or low loss condition, thence by way of the receiving volume control device RVC and the hybrid coil H to the subscriber. These voice and static impulses also pass by way of the receiving frequency-weighting network RF and the sensitivity controlling potentiometer SP to the receiving amplifier RA and its associated branches. The branch which extends through the detector DB to the receiving master relay RMB and controls the operation of the relay REHO—B has its elements so adjusted that the relay REHO—B responds to static impulses to the full extent permitted by the sensitivity adjustment of the potentiometer SP.

The other branch that extends from the receiving amplifier RA by way of detector DA to receiving master relay RMA which controls the operation of relay VR and relay REHO—A, includes the attenuator A; and the various elements of this branch are so adjusted that the relay REHO—A, while responsive to voice impulses, is considerably less responsive to static impulses than relay REHO—B due to the attenuator A. In other words the adjustment of relay REHO—B and its operating train is such that operations of the relay afford an index of the condition of the receiving path with respect to the extent and magnitude of noise or static disturbances, while the adjustment of the relay REHO—A and the elements in its operating train is such as substantially to suppress the false operations due to static while permitting the greatest possible sensitivity with respect to voice impulses. With this sensitivity ratio existing between the relays and their associated branches there is a definite relation between the number of static operations of the relay REHO—B and

the probability of static operation in the relay REHO—A. Therefore if the sensitivity of both branches is kept by the sensitivity controlling potentiometer SP at a level which permits only a predetermined tolerable number of static operations of the relay REHO—B, there will be no speech mutilating static operations, or substantially no such operations, by the receiving echo hangover relay REHO—A.

The automatic adjustment of the potentiometer SP to keep the sensitivity of the two branches at the point where this result is accomplished is effected through the medium of the sampling apparatus. At regularly recurring short intervals the sampling impulse cam S causes a brief closure of the associated contacts 30. When this occurs, assuming that relay REHO—B and relay VD are not at the time operated, a circuit is closed from the free pole of battery 39, resistance 40, winding of the sample recorder stepping magnet SM, resting contacts of relay REHO—B, closed contacts 30 of the sampling impulse cam S, and resting contact of relay VD to ground. Therefore, if relay REHO—B does not happen to be operated as a result of a static impulse during the brief interval while the contacts 30 are closed, stepping magnet SM is energized and causes the associated operating pawl 32 to advance ratchet wheel 33 of sample recorder SR one step. If it happens that the closure of the contacts 30 by the sampling cam S coincides with an interval of operation of relay REHO—B by a static impulse, then the energizing circuit of stepping magnet SM is not closed, and the ratchet wheel 33 of sample recorder SR is not advanced. Thus a "good" sample is obtained when relay REHO—B is not operated during the interval while the sampling contacts 30 are closed, and a "bad" sample is obtained when the sampling closure of contacts 30 happens at a time when the relay REHO—B is operated by static. Consequently a good sample results in a one step advance of the sample recorder SR and a bad sample is attended by no advance of the sample recorder.

It is assumed in the present instance that not more than two bad samples out of ten correspond to a condition of substantially no speech-mutilating false operation of the receiving echo hangover relay REHO—A, and therefore may be tolerated. Assuming now that the sensitivity level of the sampling relay REHO—B and the prevailing static condition are as graphically illustrated in cycle 11 of Fig. 2, it may be seen that inasmuch as the relay REHO—B does not happen to be operated by static during the first three sampling intervals, the first three samples will be good and will cause the switch arm of the sample recorder to advance three steps. As the fourth sampling interval coincides with a period during which relay REHO—B is operated, the fourth sample will be bad and therefore will not cause an advance of the sample recorder arm 34. The arm will therefore remain on the third contact point. The fifth sample as indicated in Fig. 2 is good, and therefore the arm 34 will advance from the third to the fourth contact point. The sixth sample being bad the arm will remain on the fourth contact point. The seventh sample being good, the arm will advance from the fourth to the fifth contact point, and will not be moved therefrom by the eighth sample which, as shown, is bad. The ninth sample being good causes the movement of the arm from the fifth to the sixth contact point; and the tenth sample being bad the arm remains on the sixth contact point.

The sampling cycle may consist of any desired number of sampling tests. It is assumed in the embodiment of the invention illustrated that there are ten tests in the cycle, and the ratio between the gears 28 and 29 is such that at the conclusion of ten closures of the sampling contacts 30 of cam S the contacts 31 associated with the sample counter SC are closed. The closure of the contacts 31 connects ground with the sample recorder switch arm 34 and grounds the particular contact upon which the arm is resting. The moment in each cycle at which this action occurs is represented by the vertical lines 19 drawn across the time scale of Fig. 2.

In the particular case assumed four of the ten samples that have been taken during the testing cycle have been bad, and the six good samples have caused the advance of the sample recorder switch arm 34 to the point where it is resting on the sixth contact of the series. The instant the path to ground from arm 34 is completed by the closure of contacts 31 of the sample counter SC, condenser 38 associated with the sixth contact upon which arm 34 is resting is discharged and at the same time an energizing path for the decrease relay D of the potentiometer drive is closed from battery through the sixth contact and its associated resistance 37 and arm 34 to ground by way of the sample counter contacts 31. The energization of the decrease magnet D moves the decrease clutch disc DC into engagement with the driven disc DD and starts the arm of the sensitivity controlling potentiometer SP moving in a counter-clockwise direction to decrease the sensitivity level of both the relays REHO—B and REHO—A.

The momentary closure of contacts 31 of the sample counter SC also closes an energizing path for the release magnet RM, and this magnet attracts the retaining pawl 36 to permit the arm 34 of sample recorder SR to return to normal. However, the restoring magnet RM is made slow operating by the timing network of capacity and resistances associated with it; and therefore the restoration of the arm 34 is not started until the decrease magnet D has been energized to cause the movement of the potentiometer arm. The timing of the various elements is such that contacts 31 of the sample counter are opened to remove the ground connection before the arm 34 of the sample recorder SR starts its return movement. This is to prevent the discharge of the series of condensers 38 associated with the various contact points as the arm 34 sweeps over the contact points in its return movement.

The condensers 38 act to retard to any desired degree the deenergization of the associated decrease magnet D or increase magnet I, and thus regulate the extent of movement of the arm of the potentiometer SP. The normal adjustment of the potentiometer should be such that the relay REHO—A just fails to be operated by the static impulses to a speech-mutilating extent. Any greater degree of insensitiveness on the part of the relay entails the introduction of a greater amount of attenuation into the receiving branch of the connecting circuit by means of the receiving volume control device RVC than would otherwise be necessary, and the delivery of an unnecessarily low received speech volume to the subscriber. This degree of insensitiveness on the part of the relay REHO—A corresponds to an adjustment of the potentiometer that results in the obtaining of eight, and not more than eight, good samples in ten tests. If nine or all of the

samples are good the relays REHO—A and REHO—B are too insensitive, and their sensitivity should be increased. If only seven or less of the ten samples are good, the relays REHO—A and REHO—B are too sensitive, and their sensitivity should be decreased. Therefore, the position to which the arm 34 of the sample recorder SR is moved in the test cycle with reference to the eighth step or position, which corresponds to the predetermined proper sensitivity of the relays, constitutes a measure of the extent to which the relays are too sensitive or not sensitive enough. It also constitutes a measure of the extent to which the arm of the sensitivity controlling potentiometer SP should be moved in one direction or the other to effect the proper sensitivity adjustment.

The greater or less degree of adjusting movement in one direction or the other of the arm of potentiometer SP, as indicated by the point on which the arm 34 is left at the end of a testing cycle, is governed by the timing element introduced by the values given the resistance 37 and capacity 38 associated with each of the active contact points on the sample recorder SR. These values for each contact point are so chosen that there is a greater or less time lag in the deenergization and release of the decrease magnet D or the increase magnet I in proportion to the angular separation between the contact point upon which the switch arm is left at the end of the cycle and the eighth contact point which represents the proper ratio between good samples and the total number of samples in a cycle. Thus in the case assumed where six of the samples are good, the deenergization of the decrease magnet D is delayed after arm 34 is released by the time necessary to charge the discharged condenser 38 associated with the sixth contact point. In each case the varying delays as determined by the capacities of the condensers 38 are such as to tend to move the switch arm of the potentiometer SP to a position such that the changed sensitivity of the relays REHO—A and REHO—B will be the proper predetermined sensitivity.

In Fig. 2 it is assumed that the movement of the potentiometer arm determined by the result of the testing cycle 11 is such as to reduce the sensitivity from the level indicated by the line 13 to the level indicated by the line 14. As a result in the next testing cycle designated as 12, with the same type of static, eight of the samples are good and two are bad. Therefore at the end of the cycle the arm 34 of the sample recorder SR is left resting upon the eighth contact of the series. As this position is that which corresponds with the predetermined proper ratio of good and bad samples to the total number of tests and the tolerable number of static operations of the relay REHO—A, neither the decrease magnet D nor the increase magnet I is energized, and the adjustment of the potentiometer SP remains unchanged.

As the relay REHO—B responds to voice as well as static impulses, it is necessary that the sampling operation be suspended during conversation, or while the voice impulses are actually being transmitted over the receiving path. Otherwise the voice operations of the relay REHO—B would be recorded as bad noise. This result is accomplished through the agency of the relay VD which is under the control of the relay VR included in the energization path which extends from the master relay RMA to the receiving echo hangover relay REHO—A. Incidentally the relay VD is

also operated by the energization of the relay VT included in circuit with the transmitting echo hangover relay TEHO and the transmitting short-circuiting relay TSS controlled by the transmitting master relay TMR. When either of the relays VR or VT is operated the relay VD is operated. At its back contact the relay VD opens the sampling circuit over which the relay REHO—B and the sampling contacts 30 control the stepping magnet SM. At its front contact the relay VD closes a circuit that energizes the brake magnet BM to tighten the brake band of the brake B upon its drum, thus stopping the rotation of the sample counter cam SC, the sampling cam S and the increase and decrease driving discs IC and DC. Thus the energization of the relay VD completely suspends the sampling and sample counting operations as long as the voice impulses are being transmitted over either path of the communicating circuit. Each of the relays VR and VT has associated with it a timing network which, while leaving the associated relay free to respond to voice impulses, makes it insensitive to static impulses. A brief interval after the voice impulses cease, as determined by the slow-to-release adjustment of the relay VD, the relay VD opens its front contact to release the brake B and closes its back contact to re-establish the sampling circuit. This permits the resumption of the sampling operation suspended during the passage of the voice impulses in the communicating circuit.

It is to be understood that the invention is not limited to the precise details of the organization of circuits and apparatus illustrated and described for it is apparent that numerous modifications thereof could be made for those skilled in the art within the spirit and scope of the invention.

What is claimed is:

1. In a two-way telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means connected to the receiving path and responsive proportionately to the static or noise energy in that path, and means operating from time to time in accordance with the energy indicated by said testing means to adjust the sensitivity of the voice operated means connected to the receiving path.

2. In a two-way telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means connected to the receiving path and responsive proportionately to the static or noise energy in that path, and means operating from time to time in accordance with the energy indicated by said testing means to adjust the sensitivity of the voice operated means connected to the receiving path, said means operating to reduce the sensitivity of the voice operated means for an increase in static or noise energy and to increase the sensitivity for a reduction of static or noise energy.

3. In a two-way telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated

means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means for recurrently collecting indications of the noise energy in the receiving path, and means operating from time to time to adjust the sensitivity of the voice operated means connected to the receiving path in accordance with the noise energy indicated by the collected indications.

4. In a two-way telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means for making successive series of short tests of the static energy in said receiving path, said means operating to indicate the ratio of the tests indicating the presence of static above a predetermined energy level to the total tests in each series, and means governed by the ratio thus indicated for controlling the sensitivity of the voice operated means connected to the receiving path.

5. In a two-way radio-telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means connected to the receiving path and rendered operative a predetermined number of time intervals to collect indications of static relative to a tolerable level, and means to simultaneously adjust the sensitivity of the testing means and the voice operated means connected to the receiving path in accordance with the ratio of the total collected indications to the predetermined number of collecting intervals.

6. In a two-way radio-telephone system having one path adapted for transmission in a receiving direction and a second path adapted for transmission in a transmitting direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, testing means connected to the receiving path and rendered operative a predetermined number of time intervals to collect indications of static relative to a tolerable level, means to simultaneously adjust the sensitivity of the testing means and the voice operated means connected to the receiving path in accordance with the ratio of the total collected indications to the predetermined number of collecting intervals, and means connected to the receiving path and associated with the testing means to render the latter inoperative when voice energy is present in the receiving path.

7. In a two-way telephone system having one path adapted for transmission in one direction and a second path adapted for transmission in an opposite direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, an instrumentality connected to one of the voice operated means and operated through a cycle of testing in-

tervals for indicating noise energy relative to a predetermined level, and means to effect an adjustment of the sensitivity of the voice operated means in accordance with the number of indications above the predetermined level with respect to a tolerable number of such indications above the predetermined level.

8. In a two-way telephone system having one path adapted for transmission in one direction and a second path adapted for transmission in an opposite direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, an instrumentality connected to one of the voice operated means and operated through a cycle of testing intervals for indicating noise energy relative to a predetermined level, and means to effect an adjustment of the sensitivity of the voice operated means in accordance with the number of indications above the predetermined level with respect to a tolerable number of such indications above the predetermined level, the instrumentality being rendered inoperative when voice energy is being transmitted over either of the one-way paths.

9. In a two-way telephone system having one path adapted for transmission in one direction and a second path adapted for transmission in an opposite direction, voice operated means connected to each of the paths for preventing transmission over one of the paths when transmission is being effected over the other, an instrumentality connected to one of the voice operated means and operated through a cycle of testing intervals for indicating noise energy relative to a predetermined level, and means to effect an adjustment of the sensitivity of the voice operated means in accordance with the number of indications above the predetermined level with respect to a tolerable number of such indications above the predetermined level, the instrumentality being rendered inoperative when voice energy is being transmitted over either of the one-way paths, said instrumentality including means to effect its return to its starting point to commence a new operating cycle after the sensitivity adjustment has been made.

10. The method of adjusting the sensitivity of a voice operated device connected in a two-way signaling system which consists in collecting static indications relative to a tolerable level during a predetermined number of time intervals, and utilizing the ratio of the total collected indications to the predetermined number of collecting intervals to effect a sensitivity adjustment of the voice operated device.

11. The method of adjusting the sensitivity of a voice operated device connected in a two-way telephone system which consists in collecting static indications relative to a tolerable level during a predetermined number of time intervals when voice transmission is absent, and utilizing the ratio of the total collected indications to the predetermined number of collecting intervals to effect a sensitivity adjustment of the voice operated device to a level above which a predetermined number of static operations will be tolerable.

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