

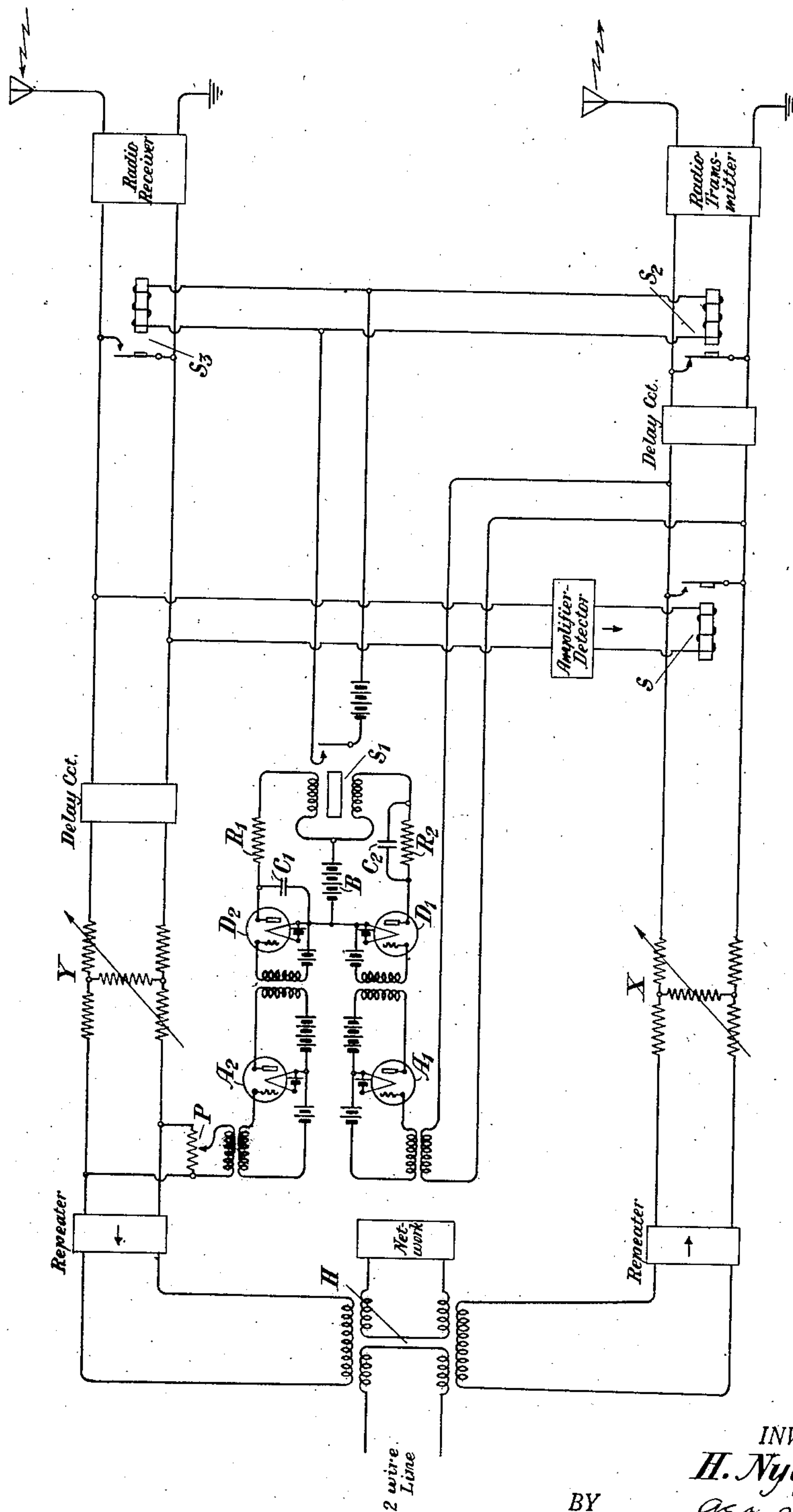
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SUPPRESSION OF ECHOES AND SINGING IN FOUR-WIRE CIRCUITS

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SUPPRESSION OF ECHOES AND SINGING IN FOUR-WIRE CIRCUITS

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This invention relates to two-way communication systems, and more particularly to two-way telephone systems which include, between two-wire lines, a four-wire circuit having one path adapted for transmission in one direction and another path adapted for transmission in the opposite direction.

While the invention is applicable to any four-wire circuit lying between two two-wire lines, it is particularly applicable to, and will be described in connection with, a four-wire circuit containing a radio link.

The term "four-wire circuit" is ordinarily used, in connection with systems including a radio link, to denote the part of the system which connects the two distant two-wire lines and includes the radio link; this term "four-wire circuit" will be used hereinafter, however, with a view to a clear description of the invention, to denote that four-wire section of a half of the complete system which lies between one two-wire line and one end of the radio link. It will readily be understood that if the system to which the invention is to be applied is an all-wire system, the radio link, as referred to herein, is replaced by a length of the four-wire circuit extending over the whole distance between the two-wire lines.

In a telephone system of this class, in which the two paths of the four-wire circuit are adapted for transmission in opposite directions, it is, under certain conditions, a requirement, if the best possible results are to be secured, that one path of the four-wire circuit be normally blocked and consequently normally disabled. This arrangement serves to prevent singing in the circuit in its normal condition. In addition, in association with each transmission path of the four-wire circuit there must be provided means responsive to waves in this path for blocking the transmission over the other path, in order to secure the suppression of echoes returning from the two-wire line over that other path. The arrangement of the four-wire circuit which is ordinarily preferable is that in which the outgoing path—that is, the one adapted for transmission to the radio link—is normally blocked, while the path adapted for

reception from the radio link is normally cleared. With this arrangement it is, of course, necessary to provide means responsive to voice waves in the outgoing path for clearing this transmission path.

In the arrangement of four-wire circuits which has been found comparatively successful in all-wire systems, an amplifier-detector device is associated with each path of the circuit. Voice waves in the transmitting (or outgoing) path enter the associated amplifier-detector, and the output causes the operation of a relay or relays to place a short circuit on, or otherwise block, the receiving path, and also to clear the transmitting path. Voice waves in the receiving path, provided this path is not blocked at the time, enter the associated amplifier-detector, and the output causes the operation of a relay or relays to block the transmitting path.

An improvement in the suppression of echoes and singing in four-wire circuits residing chiefly in simplification of the voice operated apparatus, is disclosed in the United States Patent No. 1,653,738 to H. C. Silent dated December 27, 1927. As will appear more clearly hereinafter, the applicant's invention is an improvement over the Silent invention designed to overcome certain unsatisfactory features of the operation of that arrangement.

In the Silent arrangement, a relay which controls the clearing and blocking of the paths of the four-wire circuit is connected through suitable apparatus to both transmission paths, and the effect of echo currents in the outgoing path on this relay is offset by the effect of current taken directly from the incoming path.

The principal object of the applicant's invention is to improve the balancing of these two effects, the first caused by the echoes in one path and the second caused by the incoming currents in the other path.

Another object of this invention is to provide, in combination with the simplified form of voice operated apparatus, the lock-out feature which will enable the distant speaker to hold his control of the circuit while he is talking.

The invention will be more clearly understood when the following description is read with reference to the accompanying drawing, which shows diagrammatically the essential transmission features of the applicant's improved arrangement.

The four-wire circuit is connected at its left end to a two-wire line through the usual hybrid coil H, the two-wire line being balanced by the usual network. The lower path of the four-wire circuit is adapted for transmission over a radio link (at the right) and includes the usual one-way repeater or amplifier and the usual delay circuit. The upper path of the four-wire circuit is adapted for reception from the radio link and includes a one-way repeater or amplifier and a delay circuit. The elements X and Y are regulating networks.

Associated with the transmitting path of the four-wire circuit are the amplifier A_1 and the detector D_1 . The amplifier A_2 and the detector D_2 are associated with the receiving path of the circuit.

A polar relay S_1 has one winding in the plate circuit of the detector D_1 and a second winding in the plate circuit of the detector D_2 . These two windings are differentially connected, so that a current flow in the lower winding tends to operate the relay and current in the upper winding opposes this operation. The battery B is connected as shown. The operation of the relay S_1 causes the operation of the relays S_2 and S_3 . The transmitting path of the four-wire circuit is normally blocked by a short circuit which can be removed by the operation of relay S_2 . The reception path is normally clear but will be blocked by a short circuit upon the operation of relay S_3 .

When the four-wire circuit is quiet and voice waves pass over the two-wire line to the transmitting path of the four-wire circuit, the waves enter the amplifier-detector A_1-D_1 . This amplifier-detector is operated, and the output current causes the operation of relays S_1 , S_2 and S_3 , there being no current flow in the upper winding of relay S_1 . The operation of the relays blocks the receiving path and clears the transmitting path.

When, however, noise or voice waves enter the receiving path of the four-wire link and are transmitted on to the two-wire line, they act upon the amplifier-detector A_2-D_2 and cause a current flow in the upper winding of relay S_1 which opposes the operation of the relay. If these waves are reflected in the two-wire line back over the transmitting path of the four-wire circuit, the echoes act upon the amplifier-detector A_1-D_1 , setting up a current in the plate circuit of the detector which tends to operate the relay S_1 . The magnitude of these echoes depends upon the closeness with which the two-wire line is balanced by its network. The two amplifier-detectors

are given the proper sensitivities, with due regard to this closeness of balance, and the two currents in the windings of relay S_1 tend to balance each other. Thus the operation of the relay S_1 and of the relays S_2 and S_3 is prevented or at least there is a substantial reduction of the tendency toward this relay operation in response to voice waves or noise entering the receiving side of the four-wire circuit from the radio link. In other words, there is an elimination of or at least a reduction of the tendency toward false operation of the transmitting relays by noise in the receiving side of the four-wire circuit, and, consequently, there is at least a reduced interference with the passage of voice waves from the two-wire line over the transmission path of the four-wire circuit.

Small delays in the echoes are taken care of by the insertion of a resistance R_1 and a condenser C_1 in the circuit of the amplifier-detector A_2-D_2 . This arrangement has the effect of delaying the establishment and the removal of the current in the upper winding of the relay S_1 . In order that the characteristics of the two amplifier-detectors may be similar, a resistance R_2 and a condenser C_2 are introduced into the plate circuit of the detector D_1 . This arrangement does not produce a hang-over effect in the circuit.

The circuits as described thus far are substantially those of the Silent disclosure identified above.

It is to be expected, however, in the case of transmission from the radio link that between the time when the energy enters the amplifier A_2 and the time when the reflected energy in the outgoing path enters the amplifier A_1 there will be a considerable attenuation. This attenuation tends to disturb the balance which is desired in the windings of the relay S_1 . In order to overcome this disadvantage of the simplified arrangement of Silent, the applicant associates a potentiometer P, or any other suitable device for adjusting the neutralizing current, with the input to the amplifier A_2 . This device P may be operated by a technical operator to adjust the current acting on the detector D_2 and the upper winding of relay S_1 so that it will exactly offset in that relay the effect produced in the lower winding by the attenuated echo currents in the outgoing transmission path.

Furthermore, the applicant associates with the path adapted for transmission from the radio link to the two-wire line an additional amplifier-detector as shown in the drawing. This amplifier-detector controls a relay S which, upon operation, short-circuits the outgoing transmission path, as specifically disclosed in the drawing, for instance. It is to be understood that the essential function of the additional amplifier-detector and the relay S controlled thereby is to prevent the

operation of the amplifier A_1 by voice waves traveling from the two-wire line over the transmitting path to the radio transmitter; this amplifier-detector operation may be prevented by a short-circuit effected at any point in the path over which currents in the transmitting channel must travel in order to reach and affect the amplifier A_1 . With this additional voice operated element included in the four-wire circuit, the party talking from the two-wire line over the lower transmission path to the radio link cannot break in with his speech and interrupt one who is talking from a distant point beyond the far end of the radio link; since, once the distant talker takes control of the circuit, the lower path is short circuited by the operation of the relay S and the voice from the two-wire line neither passes on to the radio link nor in any way affects the amplifier-detector apparatus controlling the relay S_1 and the relays S_2 and S_3 .

While a specific circuit arrangement has been described for the purpose of clear illustration, it is to be understood that the scope of the applicant's invention is not limited thereby but is defined by the appended claims. What is claimed is:

1. In a two-way telephone circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the first path being normally blocked at a point relatively near its outgoing end and the second path being normally cleared, an amplifier-detector associated with the first path, an amplifier-detector associated with the second path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, means associated with the input circuit of the amplifier-detector of the second path for adjusting the current therein, means responsive to the operation of said relay for clearing the first path and simultaneously blocking the second path, and means responsive to voice currents in the second path for blocking the first path at a point relatively distant from its outgoing end.

2. In a two-way telephone system including a four-wire circuit having a two-wire line connected to one end thereof, the path of the four-wire circuit which is adapted for transmission from the two-wire line being normally blocked at a point relatively near its outgoing end and the path of said circuit which is adapted for transmission to the two-wire line being normally cleared, an amplifier-detector associated with each path, a relay having two windings differentially connected and included one in the output circuit of each amplifier-detector, means associated with the input circuit of the amplifier-detector of the normally cleared path for adjusting the current therein, means responsive to the opera-

tion of said relay for clearing the normally blocked path and simultaneously blocking the normally cleared path, and means responsive to voice currents in the normally cleared path for blocking the normally blocked path at a point relatively distant from its outgoing end.

3. In a two-way telephone circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the first path being normally blocked and the second path being normally cleared, an amplifier-detector associated with the first path, an amplifier-detector associated with the second path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, means associated with the input circuit of the amplifier-detector of the second path for adjusting the current therein, means responsive to the operation of said relay for clearing the first path and simultaneously blocking the second path, and means responsive to voice currents in the second path for preventing currents in the first path from operating the amplifier-detector associated with the first path.

4. In a two-way telephone system including a four-wire circuit having a two-wire line connected to one end thereof, the path of the four-wire circuit which is adapted for transmission from the two-wire line being normally blocked and the path of said circuit which is adapted for transmission to the two-wire line being normally cleared, and an amplifier-detector associated with each path, a relay having two windings differentially connected and included one in the output circuit of each amplifier-detector, means associated with the input circuit of the amplifier-detector of the normally cleared path for adjusting the current therein, means responsive to the operation of said relay for clearing the normally blocked path and simultaneously blocking the normally cleared path, and means responsive to voice currents in the normally cleared path for preventing currents in the normally blocked path from operating the amplifier-detector associated with the normally blocked path.

In testimony whereof, I have signed my name to this specification this 20th day of October 1927.

HARRY NYQUIST.