Oct. 30, 1928. 1,689,318

B. G. BJÖRNSON

REPEATER CIRCUITS

Filed June 6, 1927

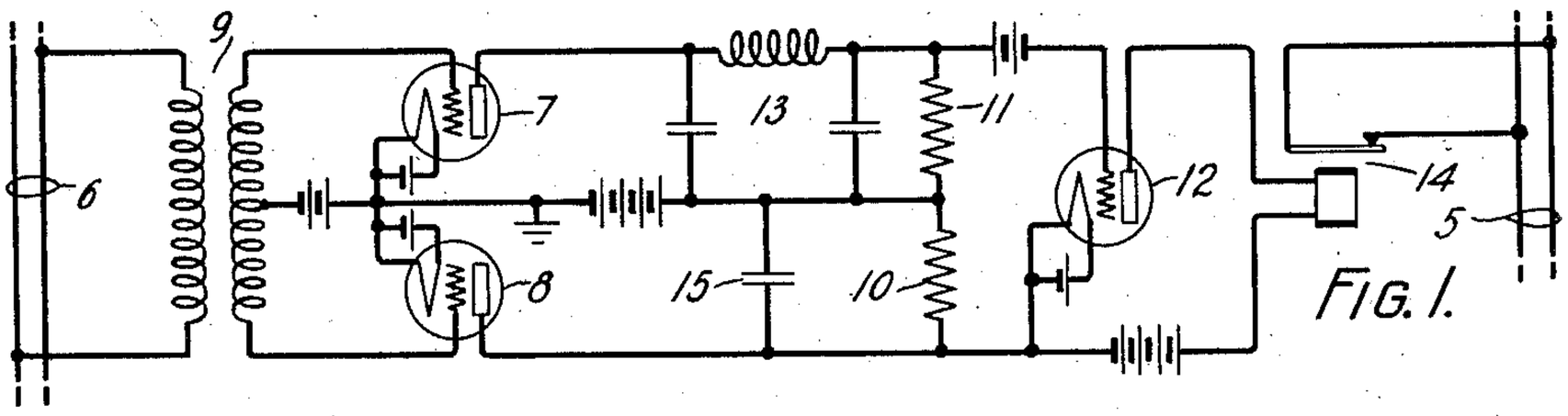


FIG. 1.

FIG. 2.

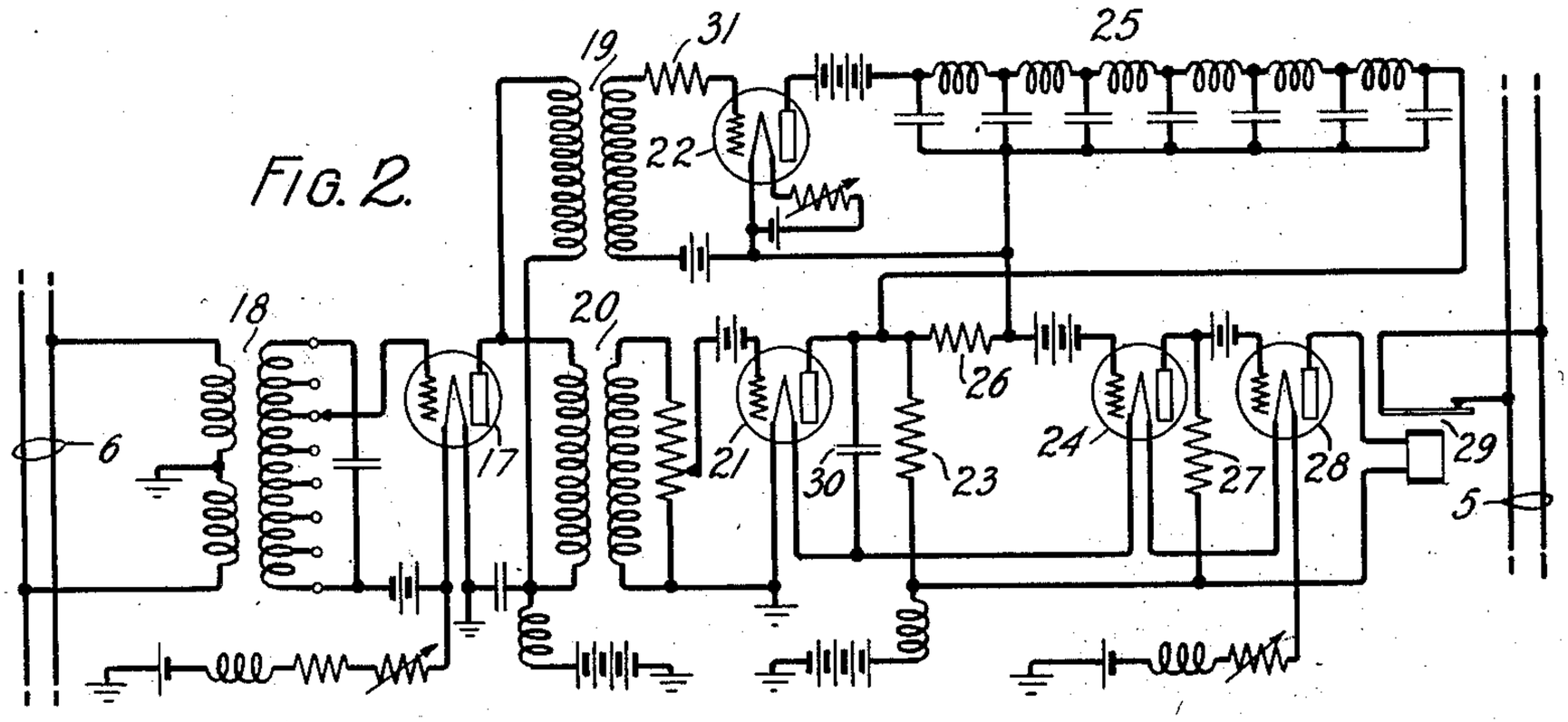
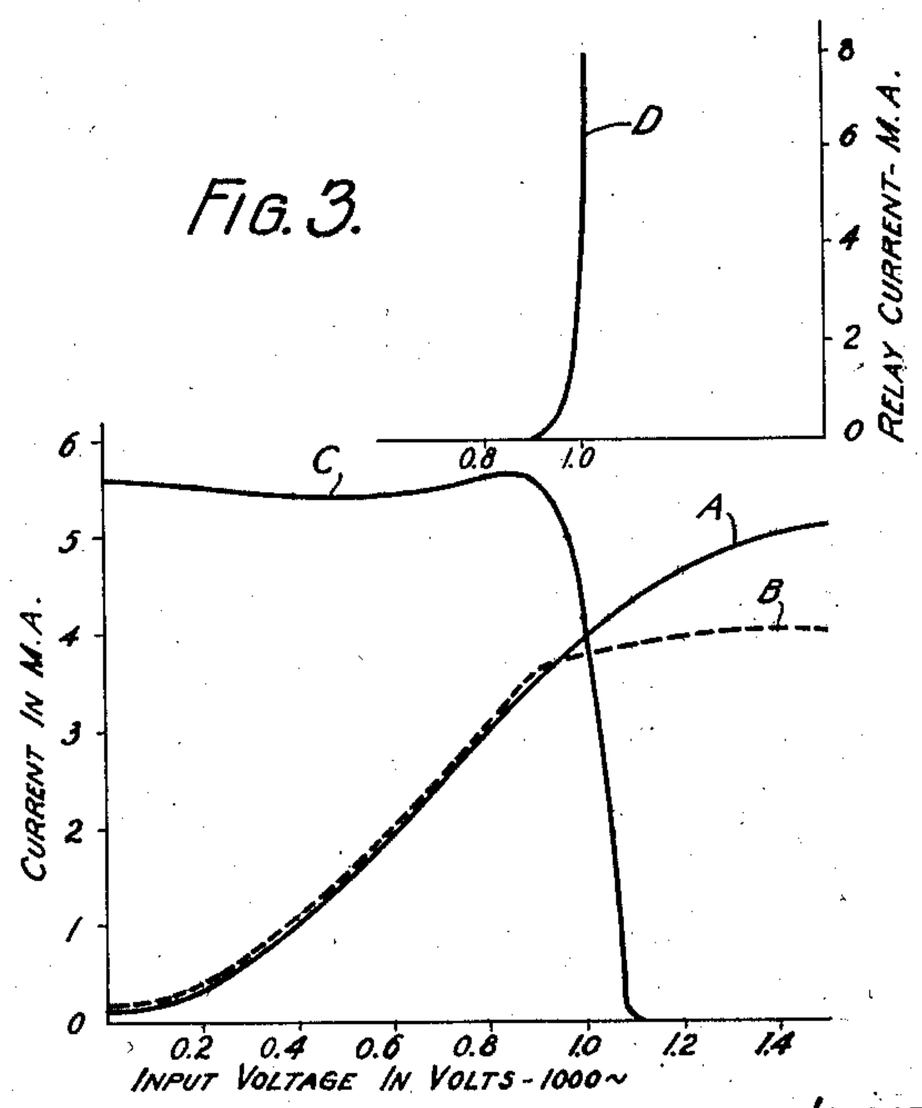


FIG. 3.



INVENTOR
BJÖRN G. BJÖRNSON
BY E. W. Griggs
ATTORNEY

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UNITED STATES PATENT OFFICE.

BJÖRN G. BJÖRNSON, OF NEW YORK, N. Y., ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

REPEATER CIRCUITS.

Application filed June 6, 1927. Serial No. 196,763.

This invention relates to transmission systems and particularly to signal controlled circuits and is in part a continuation of application Serial No. 142,566, filed October 19, 1926.

An object of the invention is to reduce the effect of line noise on the operation of signal controlled circuits.

One of the chief sources of trouble encountered in connection with the operation of signal controlled circuits such as are used for voice operated repeaters, echo suppressors and the like is the so-called "line noise". Voice controlled circuits have been devised which operate very satisfactorily on quiet lines but are either commercially inadequate or afford poor quality on noisy lines. Heretofore this difficulty has been overcome to some extent by the use of circuit arrangements adapted to differentiate between a steady current and a sudden impulse. The operation of such arrangements is based on the fact that speech energy is transmitted in impulses of short duration corresponding to spoken words, while noise energy in effect is in general relatively constant.

In one embodiment of the invention, which is disclosed also but not specifically claimed in Fig. 4 of applicant's prior application referred to above, this differentiation between noise and speech is obtained by coupling branched paths of the line over which the signaling currents are transmitted and subject to noise currents, through resistance couplings to the input circuit of the relay controlling vacuum tube, each of the branched paths containing a vacuum tube detector and one containing in addition a delay circuit. The detector tubes in the branched paths are relatively adjusted so that the steady noise currents below a certain level transmitted thereover are continuously neutralized as to their effect on the relay controlling tube, while the delay circuit serves to delay the speech impulses in one branch until the relay controlling tube is operated by the speech impulse transmitted through the other branch.

In a specific, preferred, embodiment, the invention comprises a main and an auxiliary path, each containing an electric discharge detector or rectifier the input circuits of which are connected in parallel to a signaling line subject to noise. The output of the main path is coupled through a resistance to the input circuit of an amplifier, which has its output connected to the input circuit of a detector, which in the following discussion will be referred to as the final detector. The circuits are adjusted so that current in the output of the main path effectively reduces the output current of the amplifier and increases the output current of the final detector. The output of the auxiliary path is coupled to the input circuit of the amplifier through a second resistance so as to oppose the action of the main path. The auxiliary path contains a delay circuit which acts to delay the passage therethrough of signaling impulses which are of short duration while any comparatively steady currents, such as noise currents, below a certain energy level determined by the saturation point of the detector in the auxiliary path will neutralize the effect of similar currents in the output circuit of the main path on the amplifier. The output of the final detector is connected to a relay to be controlled by the signal currents. The circuit is so adjusted that, for impressed voltages below a certain value which is determined by the maximum permissible noise level, the output currents of the main and auxiliary detectors annul each other in their effects on the amplifier and final detector. Therefore, the relay will not be affected by steady noise waves of voltages below this value but will be sensitive to speech impulses because the portion thereof transmitted through the auxiliary detector circuit are delayed therein and, therefore, produce no neutralizing effect on the portion transmitted through the main detector path in the input circuit of the amplifier. In some cases it may be desirable to employ an amplifier in place of the final detector. By the arrangement described above the effect of the noise on the line is neutralized by balancing rectified noise voltages at a point in the system where the noise is least amplified. This permits greater accuracy and flexibility of adjustment without overloading the vacuum tubes in the system.

This invention can be more readily understood by reference to the following detailed description in connection with the drawing, in which Fig. 1 shows diagrammatically one embodiment of the invention in a voice-operated repeater or echo suppressor circuit; Fig. 2 shows a modification of the circuit arrangement of Fig. 1; and Fig. 3 shows graph-

ically the relation of the currents in the various portions of the circuit of Fig. 2.

Referring first to Fig. 1, there is shown a circuit arrangement for opening a short-circuit across a line 5 in response to waves transmitted over a line 6. Such an arrangement may be used, for example, in connection with a voice operated repeater or an echo suppressor. In the latter case it would usually be desirable to arrange the relay to close a short-circuit across one line, in response to waves in the other.

The circuit arrangement comprises two three-electrode electric discharge devices 7 and 8 having their input circuits connected in push-pull relation to the line 6 through an input transformer 9. The output of the device 8 is connected directly to a resistance 10 which is connected in series with a second resistance 11 to the input electrodes of another three-electrode electric discharge device 12. A condenser 15 is connected in shunt to the resistance 10 to smooth out the rectified wave. The resistance 11 is connected to the output of the device 7 through a delay circuit 13 which comprises an ordinary low pass filter consisting of series inductance and shunt capacity. The output of the discharge device 12 is connected to the winding of a relay 14, the armature of which is arranged to normally short-circuit the line 5.

As explained above, ordinary noise currents in the line 6 are comparatively constant and the two devices 7 and 8 are so arranged that constant voltages, below a certain limiting value determined by the permissible maximum noise level, produce substantially equal output currents in the two devices. The circuit is so designed that for these voltages the potential drops across the equal resistances 10 and 11 will be substantially equal and counteract each other in their effect on the amplifier 12. However, speech waves, which are of relatively short duration, impressed on the devices 7 and 8 from the line 6 will produce different effects upon the amplifier 12, since those transmitted by the device 8 will immediately affect the amplifier while those transmitted by the device 7 will be delayed by the delay circuit 13, and their effect on the amplifier 12 will, therefore, be delayed with respect to that of the speech waves transmitted by the device 8. These rectified speech waves from the device 8 after being amplified by the device 12 will operate the relay 14 to open the short-circuit across the line 5.

Fig. 2 shows a modification of the circuit arrangement of Fig. 1. In this figure waves from the line 6 pass through an input transformer 18 and are impressed on the input of a three-electrode electric discharge device 17 which is arranged to operate as an amplifier. Connected in parallel to the output electrodes of the device 17 are the primary windings of the transformers 19 and 20. The secondary winding of the transformer 20 is connected to the input of a three-electrode electric discharge device 21 which serves as a main detector. The secondary winding of the transformer 19 is connected to the input of a three-electrode electric discharge device 22 which serves as an auxiliary detector. The output of the detector 21 is coupled through a resistance 23 to the input of a three-electrode electric discharge device 24, which is arranged to operate as an amplifier. A condenser 30 is connected in shunt to the output of detector 21 to smooth out the rectified wave. The output of the auxiliary detector 22 is connected through a delay circuit 25 to the resistance 26, which is also connected in the input circuit of the amplifier 24. Resistances 23 and 26 are so arranged that the voltage drops produced across them by the output currents of the detectors 21 and 22, respectively, oppose each other in their action on the amplifier 24. The output of the amplifier 24 is coupled through a resistance 27 to the input of a three-electrode electric discharge device 28. This device is preferably operated as a detector, but in some cases it may be found desirable to decrease the grid biasing potential and operate it as an amplifier. The output of the device 28 is connected to the winding of a relay 29, the armature of which is connected to normally short-circuit the line 5. The discharge devices are supplied with filament heating current and space current through retardation coils in the usual manner.

In some cases it may be desirable to use a filter network in place of the condenser 30 as otherwise the highly filtered output of the detector 22 will not be effective to neutralize the less thoroughly filtered output of the detector 21. It is desirable that such a network should have the same attenuation characteristic as the delay network but produce no retardation effect. Such a circuit may be not practically realizable, however, and a single section low pass filter will give good protection from false relay operation though it will slow up the operation slightly.

This circuit operates in a manner similar to the circuit of Fig. 1. For noise currents below a certain level, determined by the maximum permissible noise level, the effects of the detectors 21 and 22 neutralize each other on the input of the amplifier 24. Whereas voice waves which are substantially instantaneously transmitted by the path including detector 21, while the voice waves transmitted over the auxiliary path are being delayed by the delay circuit 25 in the output of the detector 22, are amplified by the device 24 to operate the relay 29.

The detailed operation of the circuit can best be explained with reference to Fig. 3, which shows the relation of the input voltage

of the amplifier 17 to currents in various portions of the circuit. Curve A represents the current in the output of the main detector 21. Curve B represents the current in the output of the auxiliary detector 22. As indicated, the circuit is so adjusted that these currents are of substantially the same magnitude up to the point of maximum noise protection, while beyond that point the output current of the main detector 21 exceeds that of the auxiliary detector 22. This desired current characteristic is obtained by the use of a grid-leak resistance 31 connected in the input circuit of the auxiliary detector 22. Curve C represents the output current of the amplifier 24. As indicated, this is practically constant up to 0.9 volt input, while above this point it drops off very rapidly. D represents the output current of the detector 28, i. e. the current supplied to the relay winding. As indicated, when the output current of the amplifier 24 begins to drop off, this current rises almost immediately to its final value.

Since speech impulses require a certain definite time to build up, the beginning of a speech wave may be weaker than the line noise even though the average speech energy is of a much higher level. However, if the speech impulse builds up to a level higher than the maximum noise level in a time shorter than the time of transmission through the delay network, the relay will be kept operated by the speech.

What is claimed is:

1. In a signaling system, a path for wave impulses of short duration and for relatively constant waves, branch paths connected thereto, a rectifier in each of said branches, an amplifier, a connection from each of said paths to the input of said amplifier, and means in one of said branches whereby for constant waves the effects of said branches on said amplifier substantially annul each other, while for the wave impulses the effect of one of said branches predominates.

2. The combination according to the preceding claim in which said means comprises a delay circuit.

3. In a signaling system, a path for wave impulses of short duration and for relatively constant waves, main and auxiliary branch paths connected thereto, a rectifier in each of said branches, a resistance element, a pair of electric discharge devices having input and output circuits and coupled in tandem by means of said resistance element, connections from the output of each of said rectifiers to the input circuit of the first of said devices, means associated with the rectifier in said auxiliary path whereby for constant waves the effects produced on said discharge devices by the rectified currents in said branches substantially annul each other, while for wave impulses the effect of the rectified current in the main path predominates, and a relay to be controlled by the wave impulses connected in the output circuit of the second of said devices.

4. A combination according to the next preceding claim in which the effects of the currents in the main and auxiliary paths annul each other only for constant waves below a definite energy level while above that level the effect of the main path predominates.

5. In combination a signaling line adapted to transmit signal impulses of short duration and subject to relatively constant noise waves, a main and an auxiliary rectifier each having its input associated with said line, an electric discharge device having input and output circuits, an impedance element common to the input circuit of said device and the output of said main rectifier, a second impedance element common to the input circuit of said device and the output of said auxiliary rectifier, means associated with said auxiliary rectifier whereby the voltage drops produced in said impedances by the noise waves substantially balance each other in their effects on the discharge device while for the signal impulses the effect of the voltage drop in said first impedance element predominates, and a relay to be controlled by said signaling impulses connected to the output circuit of said device.

6. A combination according to the next preceding claim, and means associated with said auxiliary rectifier whereby the voltage drops produced in the impedance elements by the noise waves only annul each other for waves below a definite energy level while above that level the voltage drop in the impedance associated with the main rectifier predominates.

In witness whereof, I hereunto subscribe my name this 31st day of May, A. D., 1927.

BJÖRN G. BJÖRNSON.