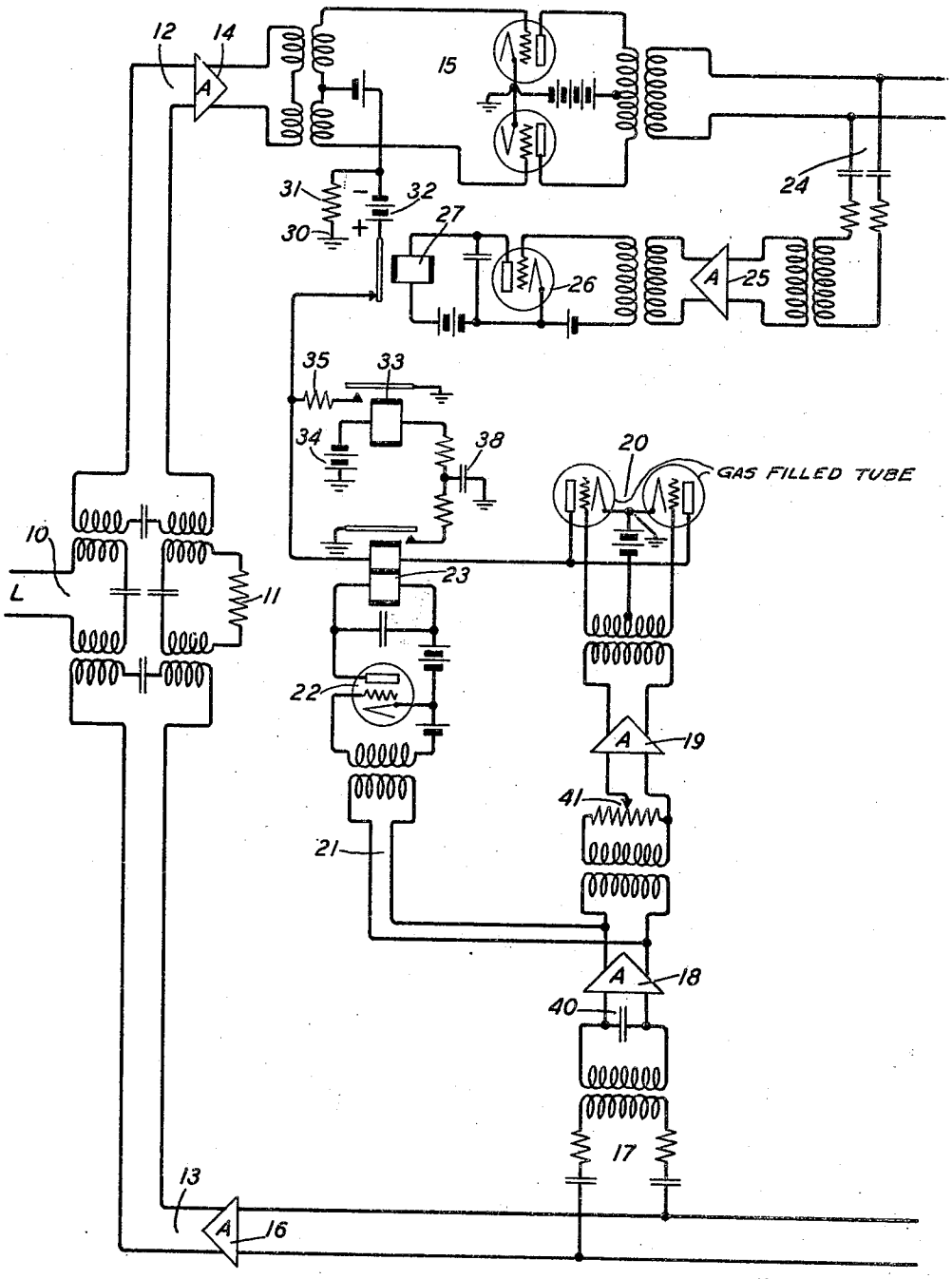
Oct. 4, 1932. B. G. BJÖRNSON 1,880,714

GAS FILLED TUBE CIRCUITS

Filed June 20, 1930



INVENTOR
B. G. BJORNSON
BY J. A. Burgess
ATTORNEY

Patented Oct. 4, 1932 1,880,714

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

GAS-FILLED TUBE CIRCUITS

Application filed June 20, 1930. Serial No. 462,500.

The present invention relates to circuits employing electric space discharge tubes and particularly gas-filled tubes.

The invention has particular application to signaling systems in which certain switching operations or transmission control functions are effected by the signals being transmitted through the system. In systems of this type in the prior art it has been common to utilize a portion of the speech or other signaling energy to control operation of an amplifier-detector circuit employing high vacuum tubes. The discharge current of these tubes is in turn used to actuate elecero-magnetic relays or to control directly a variable loss element associated with the transmission circuit to vary the amount of loss between predetermined limits. In systems of this general character, among the important factors to be taken account of, may be mentioned the operate time, sensitivity and uniformity of response of the control circuits.

According to the present invention improved results are obtained by the use of gas-filled space discharge tubes. It is found that more uniform response, more positive operation, reduction of the operating time and greater sensitivity can be secured for relatively the same amount of apparatus.

An object of the invention is to improve the operation of circuits employing gas-filled tubes. A related object is to improve the construction and operation of signal-controlled circuits in which gas-filled tubes are used.

In accordance with the invention, as will be more fully described hereinafter, a gas-filled space discharge tube is employed to effect operation of a circuit and an auxiliary control is used to supplement the control exercized by the gas-filled tube. The auxiliary control may be slower in operation, less sensitive and may have a less uniform response, its main function being first to maintain the circuit in the condition in which it was placed by the gas-filled tube, and then to cause positive release of the circuit. In addition to maintaining the load circuit in its operated condition the auxiliary control also restores the gas-filled tube to its unoperated condition. An incidental feature is a hang-over circuit associated with the auxiliary control.

The invention will be more fully understood from the following description of a terminal echo suppressor circuit as illustrated in the single figure of the accompanying drawing.

In the drawing line L is shown terminating in the usual hybrid coil generally indicated at 10, having a balancing impedance 11. Associated with this hybrid coil is an eastward transmitting branch 12 and a westward transmitting branch 13.

Transmission branch 12 includes amplifier 14 and a vacuum tube relay circuit 15 which may also be arranged to amplify the signals, or not, as desired. This branch may also contain additional amplifiers, not shown.

The receiving branch 13 contains an amplifier 16. Branched across receiving circuit 13 is the input circuit 17 of an echo suppressor including in the main control path amplifier stages 18 and 19 and a pair of gas-filled tubes associated in push-pull relation as indicated at 20. This echo suppressor also includes an auxiliary control path including branch circuit 21 and rectifier 22, the output of which includes relay 23.

Associated with the transmitting branch 12 on the output side of vacuum tube relay 15 is a disabler circuit the input of which is shown at 24. This circuit contains suitable amplifiers, one of which is indicated at 25, a rectifier 26 and relay 27.

The operation of the circuit will now be described. In the absence of speech currents incoming on the line L, the speech that is received over the westward channel 13 is impressed through the hybrid coil 10 upon line L and at same time the branch 12 is rendered incapable of transmission by disabling vacuum tube relay 15 in a manner to be described.

A small portion of the received speech in branch 13 passes into circuit 17, is amplified at 18 and 19, and is impressed on the grids of the gas-filled tubes 20. The amplification introduced at 18 and 19 controls the sensitivity of the circuit and this is preferably made

such that the initial portion of the speech arriving in circuit 17 causes the breakdown of the tubes 20 so that these tubes are immediately changed from their normal high impedance condition to a very low impedance condition. A rush of current then flows from ground at 30, through resistance 31, battery 32, back contact of armature of relay 27, upper winding of relay 23, through space paths of gas-filled tubes 20 to ground.

This sudden rise of current through resistance 31 places a large negative bias on the grids of the tubes of vacuum tube relay 15 placing this circuit in the high loss condition and preventing transmission in the eastward branch 12.

This current also causes relay 23 to energize and attract its armature. Relay 33 then is energized by current from battery 34, through the resistances shown and through the front contact of relay 23. Relay 33 in attracting its armature closes a shunt path to ground through resistance 35 in parallel with the space paths of the gas-filled tubes 20. Resistance 35 has a sufficiently low value with respect to the constants of tubes 20, battery 32 and resistance 31 that the anode voltage of tubes 20 is reduced to a point where space current no longer flows through these tubes. That is, tubes 20 are restored to their normal high impedance non-conducting condition. However, the current through resistance 31 is maintained by the existence of the circuit through resistance 35 under control of relay 33. Relay 23 is continued energized by rectified speech in the output of tube 22, the circuit of which includes a second winding of relay 23. Vacuum tube relay 15 is maintained in its high loss condition so long as relay 33 remains energized. It will be noted that relays 23 and 33 are both maintained energized independently of gas-filled tubes 20 so long as speech is present in branch 13.

When the speech waves cease in branch 13 relay 23 is deenergized causing its armature to open the energizing circuit of relay 33. The latter relay does not immediately release, however, since charging current now begins to flow into condenser 38 from battery 34 through the winding of relay 33. The purpose of this condenser is to provide a hold-over effect for relay 33. The length of the hold-over can be adjusted by proportioning the capacity of condenser 38 in relation to the resistance and inductance of the circuit as a whole. When relay 38 becomes sufficiently charged and the current in relay 33 is sufficiently low, this relay releases its armature and breaks the circuit through resistances 31 and 35 and battery 32. This removes the disabling bias from the grids of the vacuum tubes 15 and restores the eastward circuit 12 to its normal transmitting condition.

In the event that the talking party on line L has begun to speak before speech arrives over line 13 at the terminal shown in the drawing, the echo suppressor is ineffective in disabling branch 12. It will be understood, of course, that at the remote terminal the echo suppressor 17, 18, 19, 20 will be associated with branch 12 (which at that terminal is the receiving branch) and the disabler 24, 25, 26 will be associated with branch 13. It is seen therefore that the speaker whose voice reaches the far terminal before relay 27 thereat becomes energized by the opposite speaker's voice, will obtain control of the entire circuit.

Speech waves on line 12 pass in part to branch 24, are amplified at 25 and rectified by the rectifier or detector tube 26, causing operation of relay 27. As soon as the armature of relay 27 leaves its back contact the circuit from battery 32 for placing a disabling bias on the vacuum tube relay 15 is broken so that vacuum tube relay 15 is removed from control of the echo suppressor.

By connecting the input of the disabler on the output side of vacuum tube relay 15, positive control of the latter is given to the echo suppressor and false operation of the disabler is minimized. That is, relay 27 is only operated on condition that circuit 15 is able to transmit.

Amplifier 18 is shown provided with a condenser 40 across its input and amplifier 19 is provided with a potentiometer 41 in its input circuit. These elements are for the purpose of adjusting the amplitude-frequency response of the echo suppressor in proper relation to that of the disabler circuit 24, 25, 26.

It is a characteristic of the gas-filled tubes 20 that they either remain unoperated, or are fully operated by the impressed speech waves. This fact makes for positive operation of the circuit. It will be noted that relay 23 has its actuating winding in the circuit of the gas-filled tubes 20. If this were not done and if relay 23 were energized solely under control of waves in the path 21—22, it might happen that relay 23 would fail to respond to speech waves of low amplitude, but of sufficient amplitude to cause breakdown of the tubes 20. The circuit as arranged insures that relay 23 is operated whenever tubes 20 operate. Relay 23 can be maintained operated by a smaller current than is required to energize it initially. This arrangement insures both positive operation and maintenance in the operated condition throughout the duration of speech waves in line 13.

The gas-filled tubes 20 may be of any suitable design, but are preferably of the type including a heated cathode and an atmosphere of argon, neon, or a mixture of mercury and argon, or any other suitable gas at a pressure of about 0.1 millimeter. For simplicity of disclosure the filament circuits of the various discharge tubes have been shown open. In

practice they will, of course, be supplied with filament heating batteries or the equivalent. For a more complete disclosure of the construction of gas-filled tubes 20, reference may be made to A. L. Samuel, application Serial No. 465,083, filed July 1, 1930.

What is claimed is:

1. The combination with a load circuit to be operated of a gas-filled electric discharge device and an auxiliary control, an input circuit common to both, means for operating said load circuit under control of either said device or said auxiliary control, said gas-filled device acting in response to an impulse in said input circuit to initially operate said load circuit, said auxiliary control acting to maintain the load circuit in operated condition under control of said input circuit.

2. The combination with a load circuit to be operated of a gas-filled electric discharge tube and an auxiliary control, an input circuit common to both, means for operating said load circuit under control of either said tube or said auxiliary control, said gas-filled tube having a conducting and a non-conducting condition and acting in response to a wave in said input circuit to initially operate said load circuit, said auxiliary control acting in response to said wave to restore said tube to its non-conducting condition and to maintain said load circuit in operated condition independently of said tube.

3. The combination according to claim 2 in which said auxiliary control has a hang-over control maintaining said load circuit in operated condition for a predetermined time interval after cessation of the wave in said input circuit.

4. In a signal operated system, a path for the transmission of signals, a disabling circuit for determining the operative or non-operative condition of said path in response to impressed signals, said circuit comprising a gas-filled tube responsive to said signals for initially controlling said path, and an auxiliary control also responsive to said signals for controlling restoration of the path to its alternative condition.

5. In a voice-operated system, a transmission element of variable loss associated with a speech transmission path for controlling transmission thereover, means comprising a gas-filled space discharge tube having an operated and a non-operated condition, said tube being operated in response to voice energy for controlling the loss of said element, and an auxiliary control responsive to voice energy for restoring said tube to its unoperated condition and maintaining the control of said loss element.

6. The combination with a load circuit to be operated, of a gas-filled tube and an auxiliary control, a common input circuit for both, said auxiliary circuit comprising an electromagnetic relay having an armature, and a substitute circuit for the gas-filled tube circuit controlled by said armature, and means for operating said load circuit under control of either said gas-filled tube or said relay armature.

7. The combination according to claim 6 in which said gas-filled tube has a normal high impedance condition and a low impedance condition and said substitute circuit when closed under control of said relay armature shunts the space path of the gas-filled tube and restores said tube to its high impedance condition.

8. The combination with a signal transmission path of a circuit for disabling the same, a gas-filled tube responsive to signal waves for controlling operation of said disabling circuit, an auxiliary circuit also controlling said disabling circuit, said auxiliary circuit including a relay having an energizing winding in the path of the space current of said gas-filled tube, and a holding winding on said relay independent of said gas-filled tube.

9. The combination with a signal transmission circuit of a circuit for disabling the same, a gas-filled tube responsive to signal waves for controlling said disabling circuit, an auxiliary control also responsive to signaling waves for maintaining control of said disabling circuit independently of said gas-filled tube, and a hold-over relay included in said auxiliary circuit for maintaining control of the disabling circuit after the cessation of signal waves.

10. The combination with a speech transmission path and a transmission control element therein, of a hot cathode gas-filled discharge tube for altering the transmission characteristic of said control element, said tube having a high impedance zero current condition and a low-impedance, high current condition, means responsive to received speech for changing said tube from its high impedance condition to its high current condition to, in turn, alter the transmission characteristic of said control element, and a disabler circuit controlled by speech waves in said speech transmission path for interrupting the connection between said gas-filled tube and said transmission control element.

11. The combination defined in claim 10 in which said disabler circuit has its input circuit connected on the output side of said transmission control element.

In witness whereof, I hereunto subscribe my name, this 19th day of June, 1930.

BJÖRN G. BJÖRNSON.