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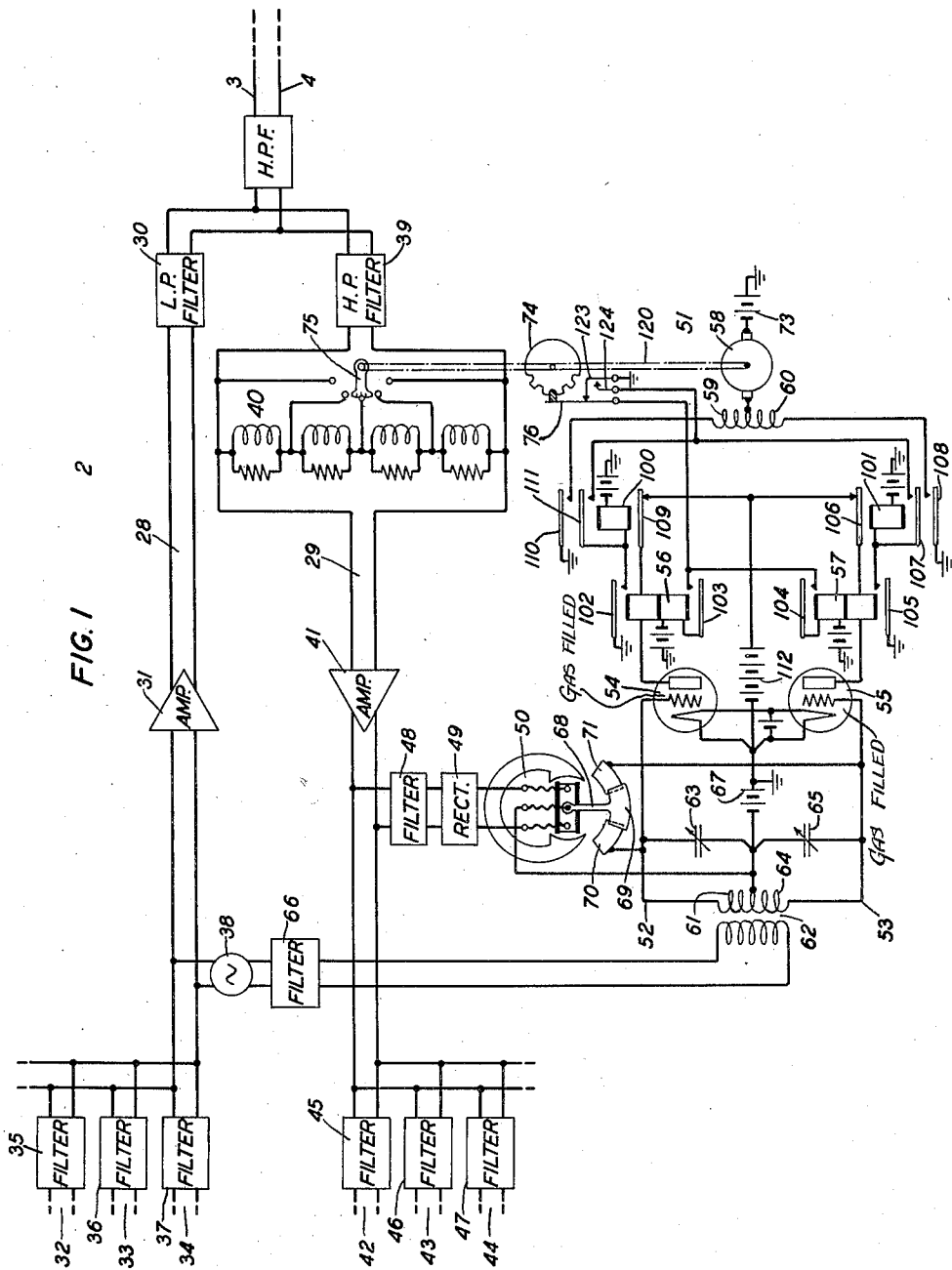
V. E. ROSENE

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CONTROL CIRCUITS

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2 Sheets-Sheet 1



INVENTOR
V. E. ROSENE
BY
Wayne B. Wells
ATTORNEY

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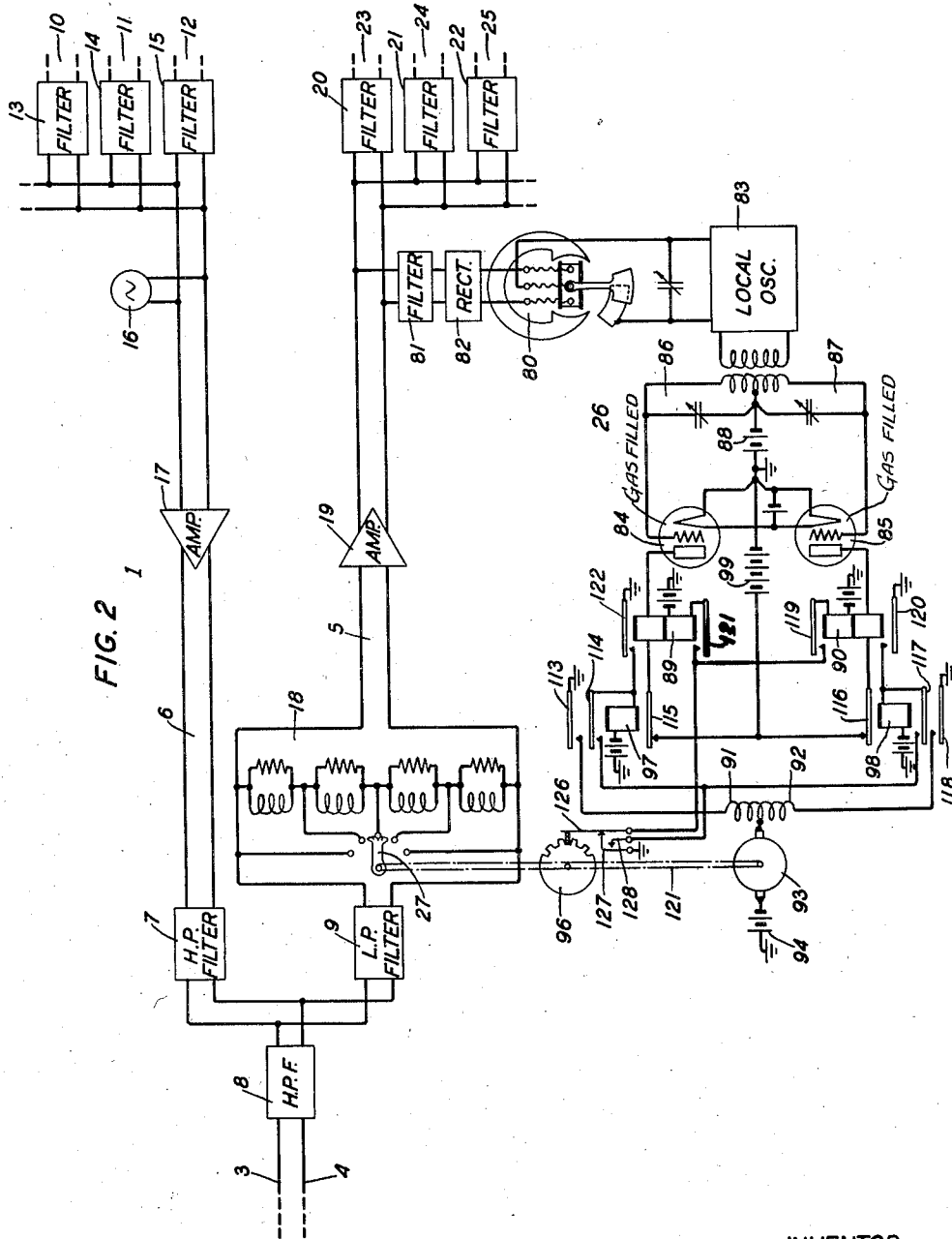
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INVENTOR
V. E. ROSENE
BY *Wayne B Wells*
ATTORNEY

UNITED STATES PATENT OFFICE

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CONTROL CIRCUITS

Victor E. Rosene, Montclair, N. J., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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12 Claims. (Cl. 178-44)

This invention relates to control circuits and particularly to control circuits for varying the attenuation on signal transmission lines.

One object of the invention is to provide a control circuit having a gas-filled space discharge device biased near the breakdown point and connected to a source of alternating current by a circuit tuned a few cycles off the normal frequency of the source that shall vary the frequency of said source and the tuning of said tuned circuit relatively to each other to control the operation of said device.

Another object of the invention is to provide a control circuit having two gas-filled space discharge devices, each biased near the breakdown point and respectively connected to a source of alternating current by two circuits, each tuned a few cycles off the normal frequency of the source that shall selectively operate said devices by varying the tuning of said tuned circuits.

Another object of the invention is to provide a control circuit having two gas-filled space discharge devices, each biased near the breakdown point and respectively connected to a source of alternating current by two circuits respectively tuned above and below the normal frequency of the source that shall vary the frequency of said source to operate selectively said devices.

A further object of the invention is to provide a signal transmission system having a galvanometer controlled by a pilot frequency current, two gas-filled space discharge devices biased near the breakdown point, and a source of alternating current connected to said devices by two tuned circuits each tuned off the normal frequency of the source by a few cycles that shall vary the frequency of said source and the tuning of said tuned circuits relatively to each other according to the operation of said galvanometer to govern the attenuation on a line circuit.

The attenuation of a signal transmission line varies according to various conditions as, for example, temperature and corrections must be made for attenuation variations to insure efficient transmission of signals. According to the present invention, means are provided under control of a pilot frequency current for controlling gas-filled space discharge devices to govern the attenuation on the transmission line.

The present invention is illustrated by means of a carrier wave transmission system. Signals are transmitted in one direction by means of carrier waves lying within one frequency range and are transmitted in an opposite direction by carrier waves lying within another frequency

range. The attenuation of the line is controlled in accordance with the energy level of pilot frequency currents which are transmitted at a constant energy level at one station and received at the other station at a level depending on the line attenuation.

In the illustrated carrier current system, a plurality of carrier currents lying within one frequency range are employed for transmitting signals in one direction. A pilot frequency lying within the same frequency range as the carrier currents is employed for controlling the attenuation of the line at a distant station. A plurality of carrier currents lying within a different frequency range are employed at the distant station for transmitting signals to the first mentioned station. A pilot frequency current lying within the second frequency range is employed for controlling the attenuation of the line at the first mentioned station.

The pilot frequency current which is employed at the distant station for controlling the line attenuation is selected from the various carrier currents by means of a filter, is rectified and employed for controlling a galvanometer. The galvanometer carries a small plate which is preferably composed of aluminum for controlling two variable condensers respectively connected to two tuned circuits. The two tuned circuits serve to connect the input circuits of two gas-filled space discharge devices to the oscillator supplying the pilot frequency current at the distant station. The term "gas" when used in the expression "gas-filled" tube in the specification and claims is employed in its broad sense and is intended to include vapors. A separate oscillator may be employed in place of the pilot frequency oscillator. The two gas-filled space discharge devices are biased to very near their breakdown points so that they may be easily operated by means of the two tuned circuits under control of the galvanometer. The two tuned circuits are tuned a few cycles off the frequency of the oscillator connected thereto. The coil of the galvanometer when moved in one direction controls one variable condenser to tune the tuned circuit associated therewith to the frequency of the pilot oscillator. The coil of the galvanometer when moved in an opposite direction controls the other variable condenser to tune the second tuned circuit to the frequency of the pilot oscillator. Each of the tuned circuits when tuned exactly to the frequency of the pilot oscillator supplies sufficient potential for breaking down one of the gas-filled space discharge devices. The gas-filled

space discharge devices control relays to operate a control motor in a forward and in a reverse direction. The control motor operates an equalizing switch which, in turn, controls an attenuation equalizer in the line at the distant station. The control motor also operates a centering cam to stop the motor and equalizing switch at the proper point.

In a system constructed as above indicated, the galvanometer is operated in accordance with the energy level of the pilot frequency current received at the distant station. The galvanometer, when operated, serves to control one or the other of the variable condensers for tuning one of the tuned circuits to the frequency of the pilot oscillator. The tuned circuits selectively operate one of the space discharge devices for operating the control motor in a forward or in a reverse direction. The control motor, by means of the equalizer switch, controls the attenuation equalizer to compensate for the change in attenuation of the line between stations. The change in the attenuation equalizer restores the galvanometer to its normal position.

In another form of the invention a local oscillator may be provided at a station which is distinct from the pilot oscillator at that station. The frequency of the current generated by the local oscillator is controlled by a galvanometer which is governed according to the energy level of the pilot frequency current received at that station. The galvanometer controls the frequency of the local oscillator by means of a variable condenser. The local oscillator is connected to two gas-filled space discharge devices by means of two tuned circuits. One of the tuned circuits is tuned to a frequency slightly above the normal frequency of the local oscillator and the other tuned circuit is tuned to a frequency slightly below the normal frequency of the local oscillator. The two space discharge devices are biased to near their breakdown points so that when the local oscillator frequency is changed to the frequency of one or the other of the tuned circuits, operation of one of the space discharge devices takes place. The space discharge devices control relays which, in turn, operate a control motor in a forward or in a reverse direction. The control motor governs an equalizing switch which in turn operates an attenuation equalizer in the line at the station. The control motor also operates a centering cam to stop the motor and equalizing switch at the proper point.

In the accompanying drawings, Figs. 1 and 2 taken together diagrammatically illustrate a carrier current transmission system provided with control circuits constructed in accordance with the invention.

Referring to the drawings a signal station 1 is connected to a distant signal station 2 by means of a line comprising conductors 3 and 4. The signal station 1 shown in Fig. 2 of the drawings comprises a receiving channel 5 and a transmitting channel 6. The transmitting channel 6 is connected to the transmission conductors 3 and 4 by means of high-pass filters 7 and 8. The receiving channel 5 is connected to the transmission conductors 3 and 4 by means of an attenuation equalizer 18, a low-pass filter 9 and the high-pass filter 8. A plurality of transmission circuits 10, 11 and 12 are respectively connected to the transmission channel 6 by means of selector filters 13, 14 and 15.

In the system employed to describe the invention a plurality of carrier currents lying within one frequency range are employed for transmiss-

sion in one direction and a plurality of carrier currents lying within another frequency range are employed for transmission in the opposite direction. The filters 13, 14 and 15 are assumed to pass carrier currents of the higher frequency range employed for transmission to the distant station 2. Suitable carrier current apparatus (not shown) is connected to the circuits 10, 11 and 12 for modulating carrier current waves with speech or other signals. An oscillator 16 having a frequency within the frequency range of the carrier currents passed by the filters 13, 14 and 15 is connected to the channel 6 for controlling the attenuation of the line at the distant station 2. A suitable amplifier 17 is provided in the channel 6.

The receiving channel 5 at station 1 comprises besides the attenuation equalizer 18 and the low-pass filter 9 for passing the lower frequency range of carrier currents transmitted from the distant station 2, an amplifier 19. Suitable filters 20, 21 and 22 which are connected to the receiving channel 5 select the carrier currents within the lower frequency range that are transmitted from the distant station. The filters 20, 21 and 22 are connected respectively to receiving circuits 23, 24 and 25. Attenuation control circuits 26 are provided at the station 1 for controlling a switch 27 to adjust the attenuation equalizer 18. The attenuation control circuits 26 will be described in detail later.

The station 2 shown in Fig. 1 of the drawings comprises a transmitting channel 28 and a receiving channel 29. The transmitting channel 28 comprises an amplifier 31 and a low-pass filter 30 which passes the carrier currents located within the lower frequency range that are employed for transmission in one direction to the station 1. Transmitting circuits 32, 33 and 34 including carrier current apparatus (not shown) are connected to the transmitting channel 28 by means of filters 35, 36 and 37. The filters 35, 36 and 37 select carrier waves within the lower frequency range. A pilot oscillator 38 is connected to the transmitting channel 28 for controlling the attenuation control circuits 26 at the station 1. The oscillator 38 has a frequency within the lower frequency range.

The receiving channel 29 at station 2 comprises a high-pass filter 39 which passes carrier currents located within the higher frequency range, an attenuation equalizer 40 and an amplifier 41. Receiving circuits 42, 43 and 44 are connected to the receiving channel 29 by means of filters 45, 46 and 47. The pilot frequency current received at station 2 from the pilot oscillator 16 at station 1 is selected by the filter 48 and rectified by a rectifier 49 for operating a galvanometer 50. The galvanometer 50 governs the operation of a motor 51 for controlling the setting of the attenuation equalizer 40.

Two tuned circuits 52 and 53 are respectively connected to the input circuits of two gas-filled tubes 54 and 55. Plate potential for the two gas-filled tubes 54 and 55 is supplied by a battery 112. The tube 54 directly controls the operation of a relay 56 having armatures 102 and 103. The tube 55 directly controls the operation of a relay 57 having armatures 104 and 105. The relay 56 controls a relay 100 which in turn controls the operation of the motor 51 in one direction. The relay 57 controls a relay 101 which in turn controls the operation of the motor 51 in a reverse direction. The motor 51 comprises an armature 58 and two field windings 59 and 60.

The tuned circuit 52 comprises a secondary

winding 61 of a transformer 62 and an adjustable condenser 63. The tuned circuit 53 comprises a secondary winding 64 of the transformer 62 and an adjustable condenser 65. The primary winding of the transformer 62 is connected through a filter 66 to the pilot oscillator 38 of station 2. The filter 66 selects current having the frequency of the pilot oscillator 38. Each of the tuned circuits 52 and 53 is tuned a few cycles off the frequency of the pilot oscillator 38 and the two space discharge devices 54 and 55 are biased by the battery 67 to near their breakdown points. Thus, the gas-filled tube 54 and the gas-filled tube 55 may be easily broken down if the circuit 52 or the circuit 53 is tuned to the frequency of the oscillator 38.

A shaft 120 which connects the motor 51 to the switch arm 75 carries a centering cam member 74. The centering cam member 74 serves to stop the operation of the motor 51 when the equalizer switch 75 has reached the center of a contact position. Notches are formed in the periphery of the cam member 74 to receive a projection extending from a contact arm 76. The cam member 74 is provided with the same number of notches as the equalizer switch has contact positions and the angular distance between the cam notches is the same as the angular distance between the equalizer switch contact positions. The contact arm 76 is resiliently held in engagement with the cam member 74. When the projection on the contact arm 76 is positioned in a notch in the cam member 74 the contact arm engages a grounded contact arm 123 and holds the grounded contact arm out of engagement with a contact member 124. When the projection on the contact arm 76 rests on a projection between two notches in the cam member 74 the grounded contact arm 123 engages the contact member 124 and disengages the contact arm 76.

The galvanometer arm 68 carries a plate 69 which may be moved adjacent to a stationary plate 70 and a stationary plate 71. The plate 69 is connected to a common terminal of the condensers 63 and 65 in the tuned circuits 52 and 53. The plate 70 is connected to the opposite terminal of the condenser 63 and the plate 71 is connected to the opposite terminal of the condenser 65. If the galvanometer is operated to move the plate 69 adjacent to the plate 70 the tuning of the tuned circuit 52 is changed to the frequency of the pilot oscillator 38 for operating the gas-filled space discharge device 54. If the plate 69 is moved adjacent to the plate 71 the circuit 53 is tuned to the frequency of the oscillator 38 and the gas-filled space discharge device 55 is operated.

The pilot frequency current received at station 2 from the oscillator 16 at station 1 operates the galvanometer 50 according to the strength of the current received. Assume that the plate 69 is moved adjacent the plate 70 in case the pilot current strength is low and that the plate 69 is moved adjacent the plate 71 in case the strength of the pilot frequency current is high. Thus, in case the pilot frequency current strength is low the circuit 52 is tuned for operating the device 54. The operation of the device 54 effects operation of the relay 56. The relay 56 by means of the armature 102 completes a circuit for operating the relay 100. The relay 56 operates the armature 103 for completing a holding circuit that includes the contact arm 76 and the grounded contact arm 123. The relay 100 completes a circuit by means of the armature 110 for energizing the armature 58 and the field winding 59 of

the motor 51 from the source 73. The motor 51 and the equalizer switch 75 connected thereto are rotated in a direction to lower the loss in the attenuation equalizer 40. The armature 109 of the relay 100 breaks the operating circuit of relay 56 and insures the breaking of the circuit through the gas filled device 54. The armature 111 of the relay 100 prepares a holding circuit for the relay 100 that is completed when the grounded switch arm 123 engages the contact member 124.

When the projection on the contact arm 76 is moved by the rotation of the cam member 74 to a position between two notches in the cam member the holding circuit for the relay 56 is broken and the holding circuit for the relay 100 is completed by the grounded contact arm 123 engaging the contact member 124. The relay 100 serves to hold the circuit of the motor 5 closed until the projection on the contact arm 76 enters the next notch in the cam member 74. The attenuation switch 75 will be moved to the next position when the projection on the contact arm enters the next notch. The holding circuit for the relay 100 is opened when the grounded contact arm 123 disengages the contact member 124. The release of the relay 100 opens the circuit of the motor 51. The equalizer switch 75 in moving from one position to an adjacent position changes the loss of the attenuation equalizer 40 so that the galvanometer 50 is restored to its normal position. Therefore the closing of the plate circuit of the gas-filled space discharge device 54 by the releasing of the relay 100 will not cause the relay 56 to be reoperated.

If the strength of the received pilot frequency current is high, the plate 69 is moved adjacent to the plate 71 for tuning the circuit 53 to the frequency of the oscillator 38. When the circuit 53 is tuned to the frequency of the oscillator 38, the space discharge device 55 is broken down for operating the relay 57. The relay 57 operates the armature 105 to complete a circuit for operating the relay 101. The relay 101 by means of the armature 108 completes a circuit from the battery 73 for energizing the armature 58 and the field winding 60 of the motor 51. The motor 51 is rotated in a reverse direction to increase the loss in the equalizer 40.

The cam member 74 operates the contact arm 76 to disengage the grounded contact arm 123 when the motor is rotated as above set forth. The separation of the contact arms 123 and 76 opens the holding circuit for the relay 57. The relay 57 opens the circuit for the relay 101 through the armature 105. The relay 101 is held closed however by a circuit completed by the grounded contact arm 123 engaging the contact member 124. When the projection on the contact arm 76 enters the next notch on the cam member 74 the contact arm 76 moves the grounded switch arm 123 out of engagement with the contact member 124 for releasing the relay 101 to stop the motor 51.

Referring to Fig. 2 of the drawings the attenuation control circuit 26 may be similar in construction and operation to the attenuation control circuits employed at station 2 if so desired. The control circuits 26 shown in Fig. 2 of the drawings are a modification of the attenuation control circuits shown at station 2.

A galvanometer 80 which is similar in construction to the galvanometer 50 shown in Fig. 1 is connected to the receiving channel 5 by means of a filter 81 and rectifier 82. The filter 81 selects the pilot frequency current received from the pilot os-

illator 38 at station 2. The galvanometer 80 controls the frequency of a local oscillator 83. The local oscillator 83 is connected to two gas-filled space discharge devices 84 and 85 by means of two tuned circuits 86 and 87. The circuit 86 is tuned a few cycles above the normal frequency of the oscillator 83 and the circuit 87 is tuned a few cycles below the normal frequency of the oscillator 83. The two space discharge devices 84 and 85 are biased by the battery 88 to near their breakdown point so that when the oscillator 83 produces a frequency corresponding to the tuning of the circuit 86 or the circuit 87, one or the other of the space discharge devices 84 and 85 is broken down.

The device 84 controls a relay 89 which in turn controls a relay 97 for completing a circuit through the armature 93 and the field winding 91 of the motor at station 1. The motor is connected to the equalizer switch 27 and a cam member 96 by means of the shaft 121. The switch 27 controls the attenuation equalizer 18. The cam member 96 which is similar in construction to the cam member 74 at station 2 controls a contact arm 126. The contact arm 126 engages a grounded contact arm 127 when the projection on the arm 126 is in a notch on the cam member. When the contact arm 126 is moved out of engagement with the grounded contact arm 127 by the cam member 96 the arm 127 engages the contact member 128.

The device 85 controls a relay 90 which in turn controls a relay 98. The relay 98 completes a circuit from the battery 94 through armature 93 and the field winding 92 of the motor at station 1. The motor at station 1 when controlled by the device 85 operates in a reverse direction. The relays 89 and 90 are similar in construction and operation to relays 56 and 57 at station 2 and the relays 97 and 98 are similar in construction and operation to the relays 100 and 101 at station 2.

The galvanometer 80 is operated according to the strength of the received pilot current for tuning the local oscillator 83 to the frequency of one of the tuned circuits 86 and 87 for selectively operating the gas-filled space discharge devices 84 and 85. The gas-filled space discharge devices 84 and 85 operate the motor 93 in a forward or reverse direction by means of the relays 89 and 97 or 90 and 98 for correcting the loss on the attenuation equalizer 18 by means of the switch 27.

Modifications in the system and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In combination, two gas-filled space discharge devices each biased near the breakdown point, a source of alternating current, two tuned circuits normally tuned off the frequency of said source, said circuits respectively connecting the devices to said source, and means for varying the frequency relationship between said source and said tuned circuits to selectively operate said devices.

2. In combination, a gas-filled space discharge device biased near the breakdown point, a source of alternating current, a circuit tuned a few cycles off the normal frequency of said source, said circuit connecting the device to said source, and means for varying the frequency relationship between said source and said tuned circuit to control the operation of said device.

3. In combination, a plurality of gas-filled space discharge devices each biased near the breakdown point, a source of alternating current, a plurality of tuned circuits normally tuned off the frequency of said source, said circuits respectively connecting the devices to said source, and means for varying the frequency relationship between said source and said tuned circuits to selectively operate said devices.

4. In combination, a plurality of gas-filled space discharge devices each biased near the breakdown point, a source of standard frequency current, a plurality of circuits tuned a few cycles off the frequency of said source and respectively connecting the devices to said source, and means for varying the tuning of said circuits to selectively operate said devices.

5. In combination, a source of standard frequency current, two tuned circuits connected in parallel to said source and each tuned a few cycles off the frequency of said source, two gas-filled space discharge devices connected respectively to said tuned circuits and biased near to the breakdown point, and means for varying the tuning of said circuits to selectively operate said devices.

6. In combination, two gas-filled space discharge devices each biased near the breakdown point, a source of alternating current, two tuned circuits connected in parallel between said source and said devices, said circuits being each tuned a few cycles off the frequency of said source, and means comprising two variable condensers respectively associated with said circuits for varying the tuning of said circuits to selectively operate said devices.

7. In combination, a gas-filled space discharge device biased near the breakdown point, a source of alternating current, a circuit tuned a few cycles off the normal frequency of said source, said circuit connecting the device to said source, and means for varying the frequency of said source to control the operation of said device.

8. In combination, two gas-filled space discharge devices each biased near the breakdown point, a source of alternating current, a circuit tuned a few cycles above the normal frequency of said source, a circuit tuned a few cycles below the normal frequency of said source, said circuits respectively connecting the devices to the source, and means for varying the frequency of said source to selectively operate said devices.

9. In combination, two gas-filled space discharge devices each biased near the breakdown point, a source of alternating current, a circuit tuned a few cycles above the normal frequency of said source, a circuit tuned a few cycles below the normal frequency of said source, said circuits respectively connecting the devices to the source, and means comprising a variable condenser for controlling the frequency of said source to selectively operate said devices.

10. In a carrier wave transmission system, a line having a variable attenuation, means for transmitting signals over said line by means of carrier waves, means for transmitting a pilot frequency current from one station to control the attenuation at a distant station, a galvanometer at the distant station, means for operating said galvanometer according to the energy level of the pilot current at the distant station, two gas-filled space discharge devices at the distant station each biased near the breakdown point, a source of alternating current, two tuned circuits each tuned a few cycles off the frequency of said source, means comprising two variable condensers

controlled by said galvanometer for governing said tuned circuits to operate one of said devices when the energy level of the pilot current is above normal value and to operate the other device when the energy level of the pilot current is below normal value, and means controlled by said devices for governing the line attenuation at the distant station.

11. In a carrier wave transmission system, a line having a variable attenuation, means for transmitting signals over said line by means of carrier waves, means for transmitting a pilot frequency current from one station to control the attenuation at a distant station, a galvanometer at the distant station, means for operating said galvanometer according to the energy level of the pilot current, two tuned circuits connected to the input circuits of two gas-filled space discharge devices at the distant station, an oscillator connected to said tuned circuits, each of said circuits being tuned a few cycles off the frequency of said oscillator and said devices being biased near the breakdown point, means controlled by said galvanometer for controlling said tuned circuits to operate one of said devices when the en-

ergy level of the pilot current is above normal value and to operate the other device when the energy level of the pilot current is below normal value, and means controlled by said devices for governing the attenuation at the distant station.

12. In a carrier wave transmission system, a line having a variable attenuation, means for transmitting signals over said line by means of carrier waves, means for transmitting a pilot frequency current from one station to control the attenuation at a distant station, a galvanometer at the distant station, two gas-filled space discharge devices at the distant station each biased near the breakdown point, an oscillator, a circuit tuned a few cycles above the frequency of said oscillator, a circuit tuned a few cycles below the frequency of said oscillator, said circuits respectively connecting the devices to said oscillator, means comprising a variable condenser controlled by said galvanometer for controlling the frequency of said oscillator to selectively operate said devices according to the line attenuation, and means controlled by said devices for governing the attenuation at the distant station.

VICTOR E. ROSENE.