July 28, 1953 P. JEANLIN 2,647,172

ELECTRONIC SWITCH

Filed June 11, 1948 3 Sheets-Sheet 1

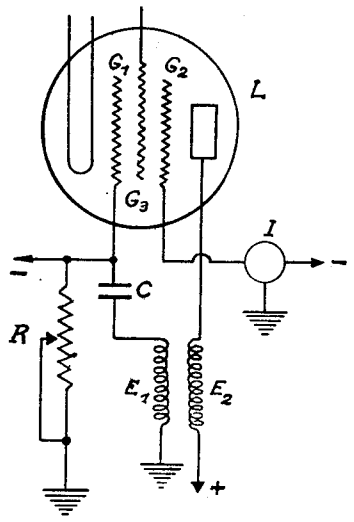


Fig.1

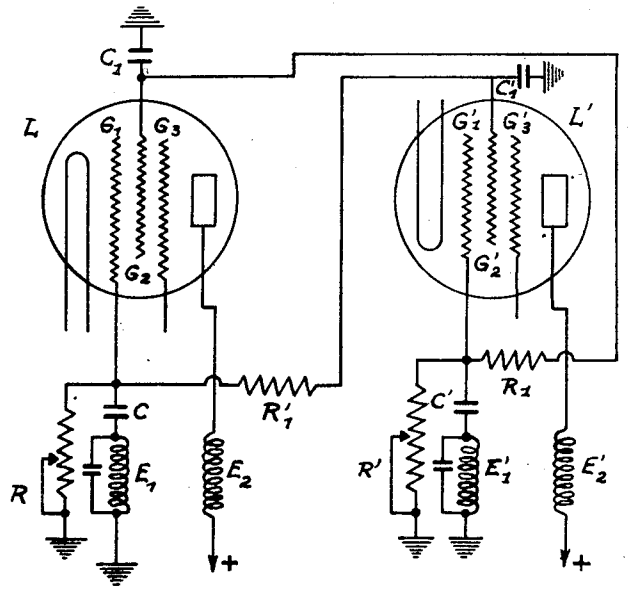


Fig.2

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July 28, 1953 P. JEANLIN 2,647,172

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Filed June 11, 1948 3 Sheets-Sheet 2

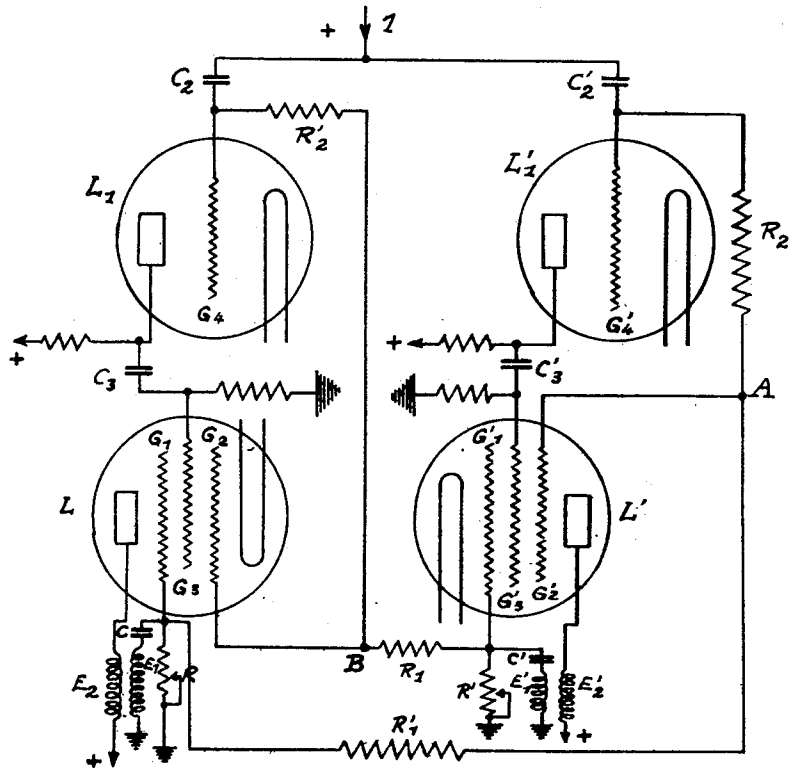


Fig. 3

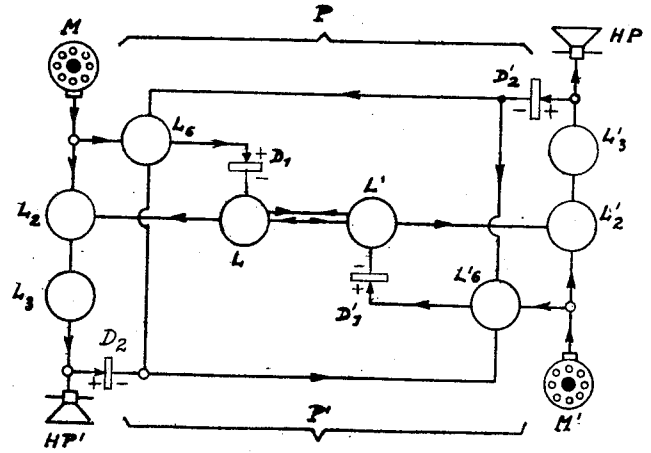


Fig. 4

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July 28, 1953 P. JEANLIN 2,647,172

ELECTRONIC SWITCH

Filed June 11, 1948 3 Sheets-Sheet 3

Fig. 5

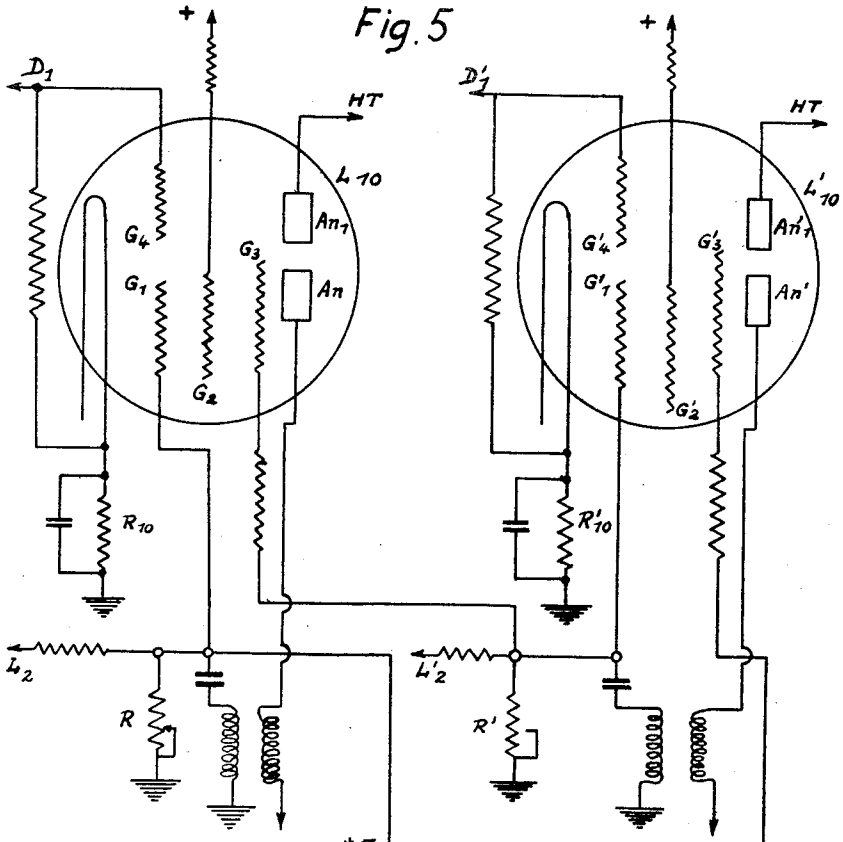


Fig. 6

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UNITED STATES PATENT OFFICE

2,647,172

ELECTRONIC SWITCH

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Application June 11, 1948, Serial No. 32,325

11 Claims. (Cl. 179—170)

1

The invention relates to an electronic switch which operates after the fashion of an electrical reciprocating device and is constituted by the combination of two three-grid valves, which form oscillators but of which only one can oscillate at a time, a first grid of each valve being connected to the second grid of the other valve, with two triodes, biased to cut off, which direct the controlling impulses towards the third grid of the oscillator in oscillation at this instant.

The electronic switch in accordance with the invention may be employed for various purposes: The invention contemplates more especially, but not exclusively, its application to two-way loud-speaker telephone installations not using manual switching for the reversal of the direction of conversation, the supply voltage which is caused to appear or disappear by the reciprocatory system being obtained naturally by the negative voltage resulting from the rectification of the oscillating high frequency.

In United States copending application Serial No. 28,445, filed May 21, 1948, for "Improvements in Loud-Speaker Telephone Installations," now U. S. Patent No. 2,545,476, apparatus has been described based upon the principle of one or two amplifiers located in each way and blocked, the blocked amplifier unblocking itself automatically upon the appearance of the modulation after having blocked the free amplifier. This apparatus works correctly in practice, but with a time constant which is not always negligible. Moreover, the blocking and unblocking remain subject to the variations of amplitude of the modulation and there may result from this jerks and irregularities during the conversation if the speakers raise or lower the voice and approach towards or recede from the microphones. These phenomena limit the uses of this apparatus. In order to remedy this, intensity-regulating systems have been introduced which make the apparatus appreciably more complicated. It has appeared preferable to withdraw the blocking and unblocking from the influence of the modulation, once the latter has fulfilled its initial function of blocking or unblocking caused by the first syllable spoken in front of one of the microphones. The invention relates to an electronic-switch system which permits this result to be attained and which functions as an electrical reciprocating device, alternately unblocking the amplifiers for operation.

Such a switch offers, in this case, the advantage of being very rapid, as the arrangement about to be described does not require complex

2

filters with large time constants for the transmission of the blocking voltages. These have, equally, moderate values which are easy to obtain.

Since the amplifiers used work as will be seen later, with stable characteristics, they cannot introduce distortion and since one of the two is blocked whilst the other is operating, the reproduction power is no longer limited by phenomena of the nature of the Larsen effect. Operation takes place fully or not at all, as with an interrupter or a relay; but with practically instantaneous rapidity which is indispensable in practice if the beginnings of phrases are not to be clipped off. The principle of operation is therefore, as has been said above, similar to that of a reciprocatory switch for electric current.

The drawing illustrates diagrammatically one example of an electronic switch according to the invention, as well as several practical applications thereof, and in the drawing:

Figure 1 is a circuit diagram of an oscillator used in a switch in accordance with the invention.

Figure 2 illustrates the coupling up of two such oscillators.

Figure 3 illustrates an arrangement of electronic switch in accordance with the invention.

Figure 4 illustrates the application of the switch to a four-line loud speaker telephone installation.

Figure 5 illustrates a practical application of the switch, and

Figure 6 illustrates the switch as applied to a station in a two-line loud speaker telephone installation.

In Figure 1, L denotes a high frequency oscillator valve, with multiple grids and preferably triple grids. In such a valve, the value and direction of coupling of the windings E1, E2 connected respectively to the first grid G1 and to the anode produce the start of oscillation with a frequency determined by the characteristics of the windings, the different capacities and voltages.

If there is introduced into the circuit of the grid G1 a condenser C and a variable resistance R as indicated in Figure 1, the oscillatory high frequency tension determines at the terminals of R the appearance of a negative tension by rectification of the high frequency by the valve constituted by the cathode of L and G1. This tension is thus proportional to the high frequency tension and has for effect to polarize the valve itself. For some suitable values of R and

C, the said polarization is sufficient for blocking the oscillation which is arrested and recovers only after discharge of C into R.

It is advantageous to utilize this phenomenon by causing the valve L to function after the manner of a blocking oscillation that is to say by giving to R and C such values that the consequence of discharges from C into R superposes on the high frequency oscillation (for example 20 megacycles) a low frequency oscillation of relaxation (for example 12.5 kilocycles-saw tooth frequency). In this manner, if the impulse received is feeble, it is certain that at the end of a very short time the oscillator L will be blocked. In practice, the phenomenon of blocking is obtained by using a condenser C of 500 pf. (1 pf.$=10^{-6}\mu$f.) for a resistance R of 250,000 ohms.

In these conditions, if a small negative tension is applied to a grid, other than G1, for example to G2, as by an appropriate switch I, this will cause the oscillation to disappear.

If a system such as that in Figure 2 be now considered, two high frequency oscillators L and L^1 are concerned instead of one. In each of these, the grid G2 (or G^12) is connected to the grid G^11 (or G1) of the other by a coupling resistance R1 or R^11 itself uncoupled by a condenser C1 or C^11. In practice it is necessary to eliminate the alternative component between G1 and G^12 (or G2 and G^11) and for the purpose the choke resistance of R1 (or R^11) is used, the high frequency component on G^12 (or G^11) being eliminated to earth by the uncoupling condenser C1 (or C^11). In effect, a filter is provided.

If it be assumed that the valve L oscillates, it will be seen that the grid G^12 of L^1 will be polarized negatively by the tension rectified at the terminals of R^11; L^1 therefore cannot oscillate as has been shown above. If the first oscillator L ceases, the oscillator L^1 is free immediately and polarizes in its turn the grid G_2 of L, preventing it oscillating even if the normal conditions of oscillation are otherwise re-established. Therefore, one only of the two valves can oscillate at one and the same time.

In effect, the principal role of each valve L or L^1 is to furnish a negative tension to the middle grid of the other.

It suffices then to send in turn an impulse of suitable polarity to one of the electrodes of the valve in action for stopping its oscillation and for working the other valve which maintains the blocking of the first; the same result is evidently obtained by applying a negative tension to the third grid G3 (or G^13) of each valve.

In Figure 3, an electronic switching arrangement in accordance with the invention is realized by the addition to the two valves L and L^1 of two triode valves L1 and L^11. The circuits are as follows: the grid G1 of L is connected, as in Figures 1 and 2, on the one hand to a variable resistance R and through a condenser C to an excitation winding E1, and on the other hand through a resistance R^11 to the grid G^12 of L^1; it is the same for G^11 and G2. Moreover, G1 is connected in shunt from the point A to the grid G^14 of L^11 through a charge resistance R2 and G2 is connected in shunt from the point B to the grid G4 of L1 through a second charge resistance R^12. On the other hand, the impulse which controls the switch arrives at I and is transmitted to G4 through a condenser C2 and to G^14 through a condenser C^12. Finally, the connection of the triodes L1 and L^11 in relation to the valves L and L^1 is that of a standard stage amplifier. The anode of L1 is connected through a condenser C3 to the grid G3 of L, and the anode of L^11 is similarly connected through a condenser C^13 to the grid G^13 of L^1.

The operation of the switching system is as follows: the triodes L_1, L^1_1 are over polarized by the oscillators L, L^1 and direct the control impulse in turn to that valve L or L^1 which is in oscillation. In practice, if a positive control impulse arrives at I and if it is supposed that L is oscillating (L^1 beng blocked) it results from the oscillation of L that L^1_1 is blocked by the negative tension applied to R_2. As L^1 does not oscillate, L_1 is on the contrary free. The positive impulse arriving at I has no effect therefore upon the blocked L^1_1 but arrives at L_1 which transforms it into a negative impulse, and transmits it to the grid G_3 of L. The oscillation of L then ceases immediately owing to over polarization.

On the other hand, the impulse which has been transmitted by the condenser C_2 to the grid G_4 of L_1, returns, by shunt, to the grids G_2 of L and G^1_1 of L^1 through R^1_2 and B.

The operation is the same when L^1 is oscillating and L is blocked. It will be seen therefore that the switching arrangement functions according to the principle of a to-and-fro electric system, the impulse being transmitted automatically to the oscillator unblocked at the moment for immediately blocking it whilst the other is unblocked.

An important application of the switching arrangement is that of blocking and unblocking alternately amplifiers in a two-way loud speaker telephone installation.

A first example of application in the case of a four line installation, is illustrated in Figure 4. For simplicity, a single line is used to represent the two lines of each way and circles represent the different valves employed.

Each station P (or P_1) comprises a microphone M (or M^1) and a loud speaker HP (or HP^1). Between M and HP^1 is interposed the usual amplifier consisting for example of two valves L_2 and L_3, and between M^1 and HP is inserted a similar amplifier $L^1_2L^1_3$. In shunt between M and L_2 there is an amplifier L_6 and between M^1 and L_2 there is in shunt another similar amplifier L^1_6. The installation comprises, moreover, two oscillator valves L and L^1 of the type indicated above and forming with the valves L_2 and L^1_2 the switching means. L_6 is connected to the valve L of the switching arrangement by a rectifier D_1. Similarly, L^1_6 is connected to the valve L^1 of the switching arrangement by a rectifier D^1_1. On the other hand L and L_2 are directly connected together as also are L^1 and L^1_2. Finally, between L_3 and HP^1 and similarly between L^1_3 and HP there are connected in shunt rectifiers D_2 and D^1_2 which are connected also with L_6 and L^1_6. The rectifiers D1, D^1_1, D_2, and D^1_2 have a polarity as shown in the drawing.

With this arrangement, the operation of the installation is as follows: If it be assumed that L procures the negative tension which blocks L_2 and L^1, it follows that L^1_2 is not blocked since L^1 does not oscillate and speech passes normally from M^1 to HP, that is to say from P^1 to P.

If, now, P wishes to speak, the microphone M is impressed and the valve L_6 sends an amplified modulation, rectified by D_1, which stops the oscillation of L. At this moment, L_2 is unblocked and L^1 can then oscillate. The oscillator L^1_2 is then blocked as well as L the blockage of which

is maintained. Speech is then transmitted freely from M to HP^1, that is to say from P to P^1, whilst $L^1{}_2$ prevents P^1 from speaking. At the same time, D_2 furnishes a cut-off polarization to $L^1{}_6$ which prevents the influence of HP^1 upon L^1 and this sends by $D^1{}_1$ the corresponding impression to L^1. At the same time, also, L_6 is restrained to avoid the permanent sending of a tension to D_1, the purpose of this being to accelerate the unblocking. When M becomes silent, D_2 frees $L^1{}_6$ and M^1 can take over the speeech by unblocking in the same manner $L^1{}_2$ whilst restraining L_6 and $L^1{}_6$ through $D^1{}_2$.

As will be seen, the rectifier D_2 plays a double role: First, it withdraws L_6 from the modulation action emitted by M until L_6 fulfills its purpose and has unblocked L_2; moreover, it prevents the valve $L^1{}_6$ from transmitting to the rectifier $D^1{}_1$ the modulation arising from the action of H^1P upon M^1 (Larsen effect). Second, the role of D_2 is analogous in the other direction, as it suppresses the Larsen effect at the station P. There results from this arrangement the very great practical advantage that it is possible, without inconvenience, to mount M and HP, as well as M^1 and HP^1 in a single box which considerably simplifies the installation at each station.

In Figure 5 there is illustrated a practical form of the improved switching means. This comprises two heptodes preferably of the type ECH21, which oscillate with high frequency. These valves really consist of a triple grid and a triode combined, with a cathode common to two anodes An and An_1 (An^1 and $An^1{}_1$).

Assume that the valve L_{10} plays the part of the valve L in the preceding figures, the triple grid of L_{10} oscillates with high frequency and blocks $L^1{}_{10}$ by polarization of $G^1{}_3$ from R. The same tension also blocks L_2, Figures 4 and 5. The positive tension from D_1 (unblocking impulse) is given by the rectification of the modulation coming from L_6 and rectified by D_1, and it is transmitted to the grid G_4 of the triode element. (This latter corresponds to the valve L_1 [or $L^1{}_1$] of Figure 3.) This positive tension has for effect to augment the anode current of the triode element. The circuit is closed again by the cathode common to the triode and triple grid elements by the resistance R_{10}. The tension at the terminals of R_{10} augments, the same with the polarization of G_1 and G_3, and the oscillation is arrested. This blocking results in the unblocking of L_2 and $L^1{}_{10}$, whereupon the latter is put into oscillation and maintains the blocking of L_{10} primed by D_1. P can then speak to P^1 but the opposite way is blocked. The functioning of $L^1{}_{10}$ is exactly similar.

In Figure 5, the impulses have two different origins (D_1 and $D^1{}_1$) and not a single origin as in Figure 3. Also, for avoiding the employment of a fifth grid, a positive impulse is sent to G_4 which comes to the same thing.

It will be understood from the foregoing that the time constants of the blocking and unblocking circuits are determined in such manner that between two syllables pronounced by one of the speakers the other can take over the speech (this will be the case for example with the circuits of D_2 to L'_6 and of $D^1{}_2$ to L_6, in the example illustrated in Figure 4).

Another example of application of the electronic switching arrangement according to the invention will now be given. This is the case of an ordinary telephone installation with two lines. Figure 6 represents very diagrammatically one of the stations, the lines being represented, for greater simplicity, by a single drawing line, the different valves by circles and the switch by a square X. The second station may be of any suitable type. It will be seen that the elements are the same as in Figure 4 with the exception of the microphone M^1 and loud-speaker HP^1 which are replaced by a transformer T which permits of the sending over the two wires of the system Z modulations emitted by M and of the arrival at the loud-speaker HP of modulations coming over the two wires of the system Z. In the present case, however, the communications being always in the same direction upon each line, it is possible to replace the well-known differential transformer used by the French Telephone Administration by a simple adaptation transformer of three windings, one of these being connected to the system Z and the other two respectively to L_3 and $L^1{}_2$ (that is to say to M and to HP). The operation is the same as that of the arrangement in Figure 4. In Figures 4 and 6, the arrows indicate the path followed by the impulses between the different units.

The result of the foregoing is that a switching arrangement means conforming with the invention gives to an installation in which it is employed the following advantages:

1. A single amplifier working at one time; the power is not limited and the loud-speaker can be put in the same box as the microphone.

2. The amplifiers having no intermediate position between blocking and unblocking (all or nothing) there is no distortion due to variations of polarization no more than there is variation of power during audition.

3. The use of independent and regulatable amplifiers for procuring the blocking and unblocking tensions permits of precise regulation of the throwing out of the inversion and prevents the superposition of modulations of one way upon the other.

What I claim is:

1. An electronic switch comprising in combination a pair of electronic valves respectively having an anode, a cathode, and a plurality of grids, a control winding connected to the anode and an oscillating circuit including a condenser for coupling said control winding through said condenser to one of said grids, a tapping point between said condenser and said one grid, a resistance having one terminal connected to ground and another terminal connected to said tapping point, and a second resistance connecting said tapping point and thereby said one grid in one of said valves with a second grid in the other of said valves, each of said connected second resistances and second grids having a junction point therebetween with a condenser connecting said junction point to ground.

2. An electronic switch comprising two pentodes each having a cathode, an anode and a first, second and third grid, the first grid of each pentode being connected with the second grid of the other through a resistor, the first grid of each tube being connected through a resistor to ground, the second grid of each tube being connected through a condenser to ground, the anode of each tube being inductively coupled with the first grid of its own tube through a grid input circuit, there being a condenser in series between said input circuit and said first grid.

3. An electronic switch comprising a pair of vacuum tube oscillators respectively having at least two grids, and a biasing resistor connected

to one of said grids for developing a negative potential in response to operation of the oscillator of which said one grid forms a part, the other of said grids being a control grid, a pair of circuits respectively operable to apply the negative potential developed by operation of one of said oscillators to the control grid of the other of said oscillators, each of said circuits including means for filtering the alternating components therefrom.

4. In a two-way communication system having at least a pair of stations respectively provided with a transmitter and a receiver and transmission lines connecting each transmitter at one of the stations with a receiver at the other of the stations, the invention which comprises the combination with the transmission lines of an electronic switch comprising a pair of electronic valves respectively having an anode, a cathode, and a plurality of grids, a control winding connected to the anode and an oscillating circuit including a condenser for coupling said control winding through said condenser to one of said grids, a tapping point between said condenser and said one grid, a resistance having one terminal connected to ground and another terminal connected to said tapping point, and a second resistance connecting said tapping point and thereby said one grid in one of said valves with a second grid in the other of said valves, each of said connected second resistances and second grids having a junction point therebetween with a condenser connecting said junction point to ground, each of said lines having an electronic amplifying valve therein, each of said electronic switch valves being connected respectively to a different one of said amplifying valves, and means under the control of the transmitter of each station for generating a blocking potential and applying it to one of the grids of the electronic switch valve connected to the amplifying valve in the line to which said transmitter is connected.

5. The invention claimed in claim 4 wherein there is provided a transformer for coupling the transmitter and receiver of one of said stations into the system.

6. In a two-way communication system having at least a pair of stations respectively provided with a transmitter and a receiver and transmission lines connecting each transmitter at one of the stations with a receiver at the other of the stations, the invention which comprises the combination with the transmission lines of an electronic switch comprising a pair of electronic valves respectively having an anode, a cathode, and a plurality of grids, a control winding connected to the anode and an oscillating circuit including a condenser for coupling said control winding through said condenser to one of said girds, a tapping point between said condenser and said one grid, a resistance having one terminal connected to ground and another terminal connected to said tapping point, and a second resistance connecting said tapping point and thereby said one grid in one of said valves with a second grid in the other of said valves, each of said connected second resistances and second grids having a junction point therebetween with a condenser connecting said junction point to ground, each of said lines having an electronic amplifying valve therein, each of said electronic switch valves being connected respectively to a different one of said amplifying valves, each transmitter having an auxiliary amplifier and a rectifier connecting it to one of the grids of that electronic switch valve which is connected with the amplifying valve in the line to which said transmitter is connected.

7. The invention claimed in claim 6 wherein each of said lines has a rectifier connected thereto at a point between its connection to the receiver and the amplifying valve in such line for supplying a rectified control voltage to both of said auxiliary amplifiers.

8. In a two-way communication system having a pair of stations respectively provided with a transmitter and a receiver and transmission lines connecting each transmitter at one of the stations with a receiver at the other of the stations, the invention which comprises the combination with said transmission lines of amplification means in each of said lines for amplifying signals being transmitted thereby, a pair of oscillation generator means including means connecting each of said generator means with the other whereby only one of said generator means may oscillate at any given time and whereby the generator means which is oscillating produces a biasing control voltage for blocking the oscillation of the other, and means inter-connecting said pair of lines and said pair of generator means whereby the biasing potential produced by one of said generator means is effective to render the amplification means in one of said lines inoperative, and the biasing potential produced by the other of said generator means is effective to render the amplification means in the other of said lines inoperative.

9. In a two-way communication system having a pair of stations respectively provided with a transmitter and a receiver and transmission lines connecting each transmitter at one of the stations with a receiver at the other of the stations, the invention which comprises the combination with said transmission lines of amplification means in each of said lines for amplifying signals being transmitted thereby, a pair of generators respectively operable to generate high frequency oscillations and including means for developing a biasing potential in response to oscillation thereof, means inter-connecting said generators for applying the biasing potential of the generator which is oscillating to the other to prevent oscillation of the other so that only one of said generators is in oscillation at any one time, means connecting each of said amplification means with one of said oscillators whereby the biasing potential produced in response to oscillation thereof is effective to render the amplification means connected thereto inoperative, and a control means for each of said lines responsive to the impression of a signal to be transmitted over such line for preventing oscillation of the generator means connected to the amplification means in such line to thereby render said last-named amplification means operable to amplify the signal to be transmitted.

10. The invention claimed in claim 9 together with a means associated with each of said amplification means in one of said lines and responsive to the amplification of a signal thereby for preventing operation of the control means for the other of said lines.

11. An electronic switch comprising a pair of vacuum tube oscillators respectively having at least two grids, and a biasing resistor connected to one of said grids for developing a negative potential in response to operation of the oscillator of which said one grid forms a part, the other of said grids being a control grid, and a

pair of circuits respectively operable to apply the negative potential developed by operation of one of said oscillators to the control grid of the other of said oscillators.

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