Nov. 26, 1935. G. A. MATHIEU 2,022,357

RADIO TELEPHONY SYSTEM

Filed Dec. 6, 1929 3 Sheets-Sheet 1

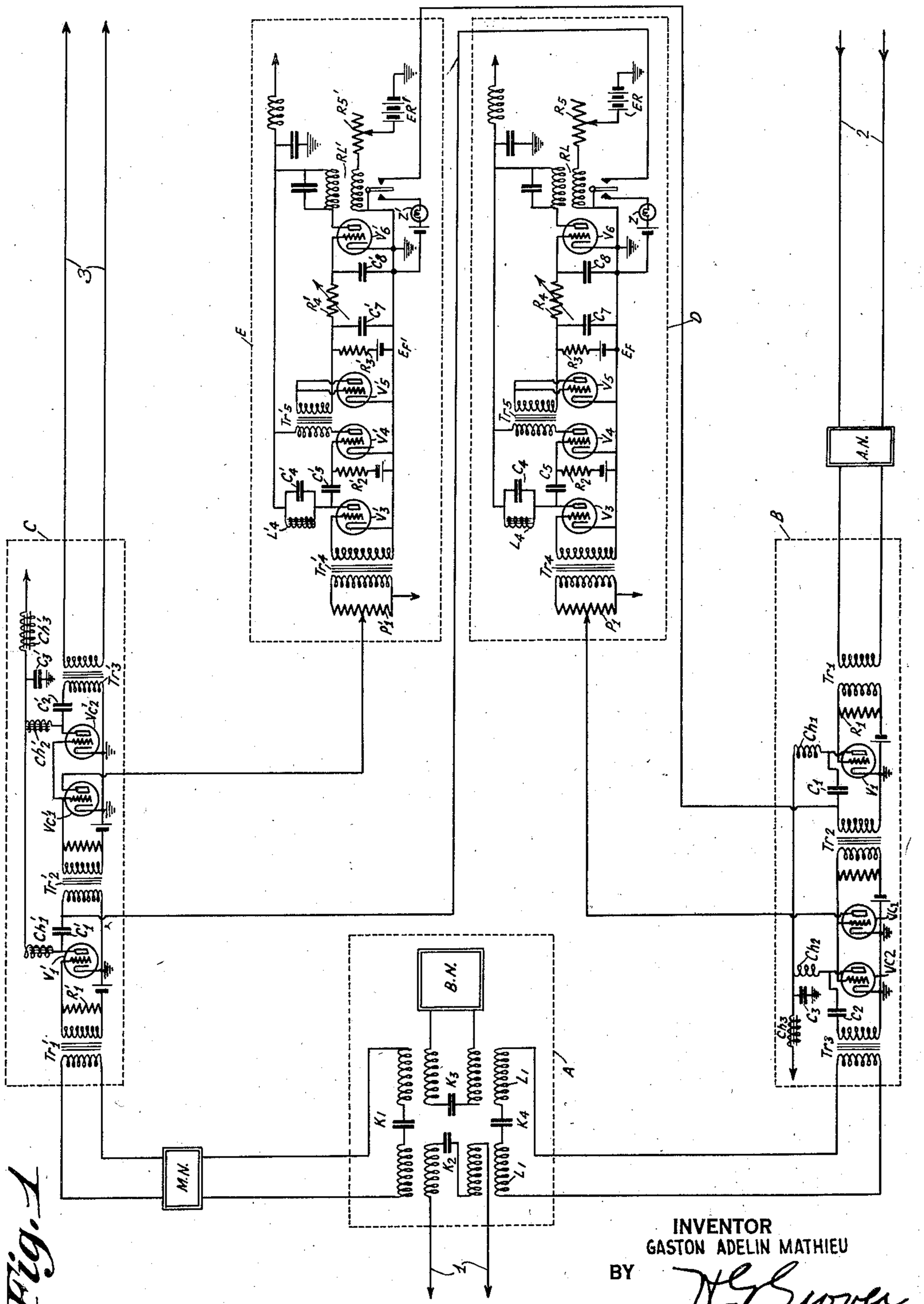

Fig. 1

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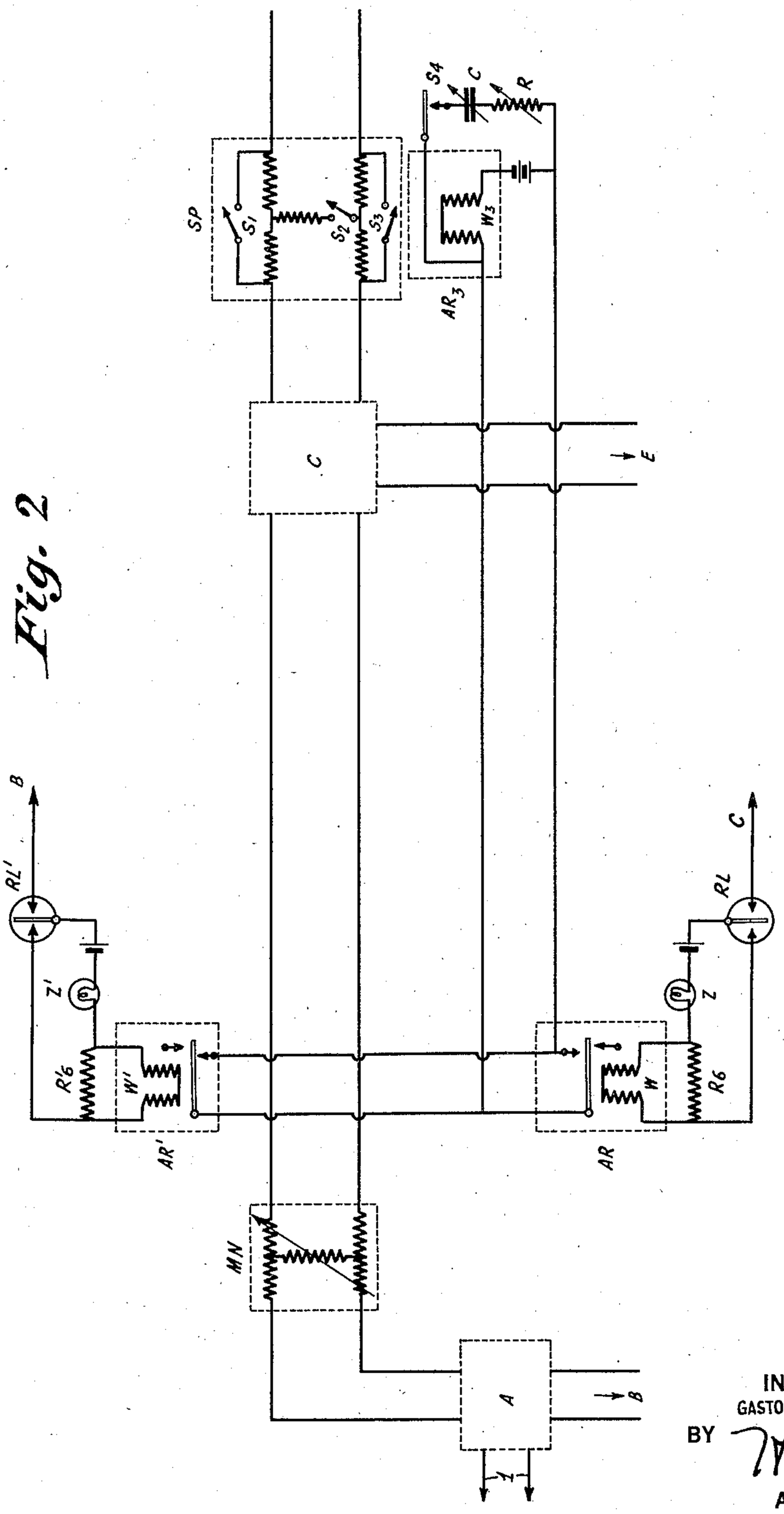

Fig. 2

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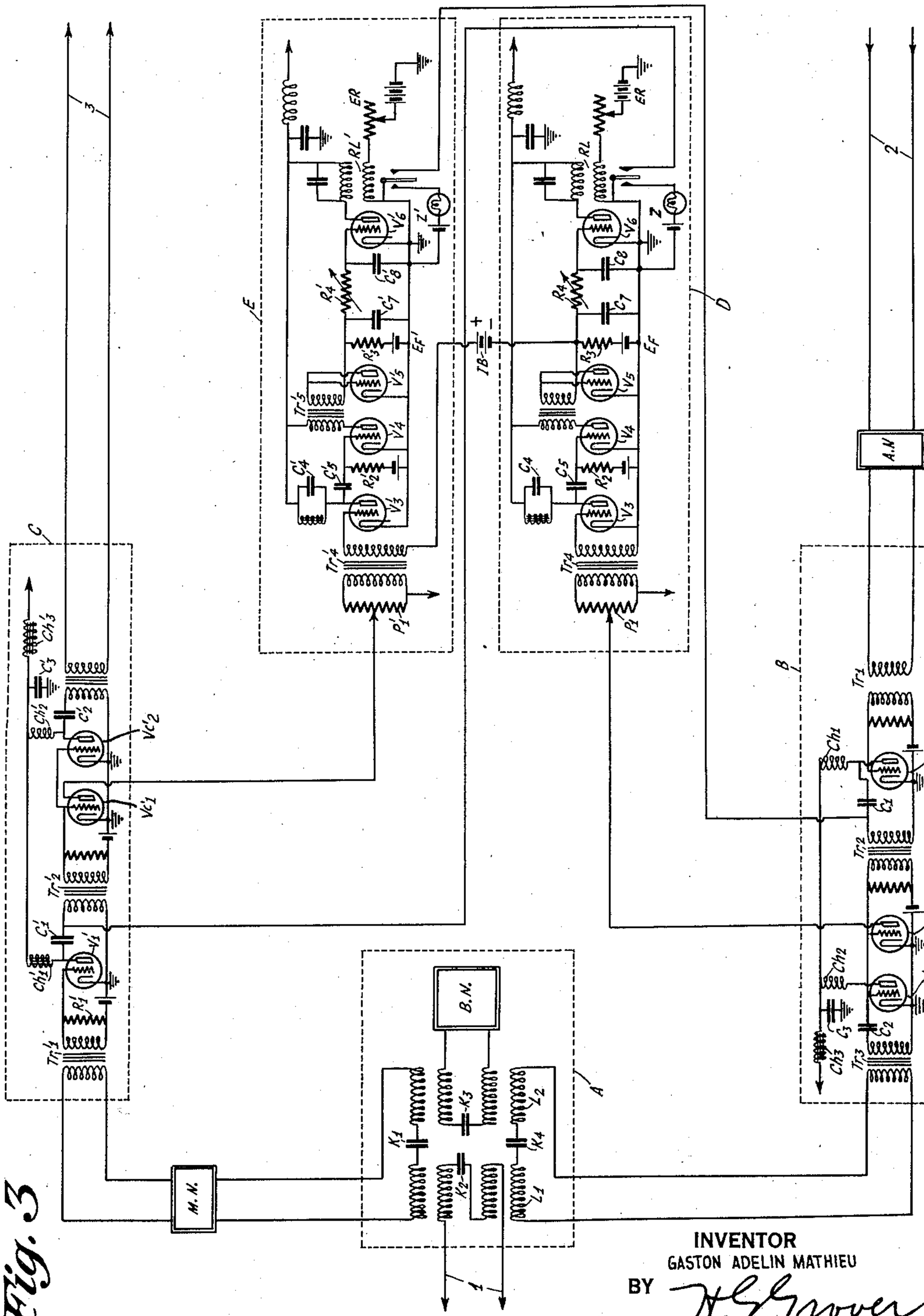

Fig. 3

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2,022,357

RADIO-TELEPHONY SYSTEM

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6 Claims. (Cl. 179—170)

This invention relates to radio telephone systems and the like, and has for its object to provide an improved system suitable for use on long distance radio telephony, whereby two way communication may be effected in a satisfactory manner.

According to this invention a telephone station comprises means operated automatically by the voice or the like to be transmitted for simultaneously cutting out or greatly reducing the effectiveness of a receiving amplifier in said station and a transmitting amplifier in the station with which said station is in communication. The station with which communication is to be effected is provided with similar means operated automatically by the voice or the like to be transmitted from that end.

From another aspect, the invention may be regarded as consisting essentially in the provision in a telephone station of means operated automatically by the voice or the like to be transmitted, for cutting out or greatly reducing the effectiveness of the receiving amplifier in said station and means, operated automatically upon the reception of signals, for cutting out or greatly reducing the effectiveness of a transmitting amplifier in said station.

The arrangement is such that when no communication is being effected, all the amplifiers are in normal operation and preferably means are provided for adjusting the rapidity of operation of the automatic means.

Preferably also means are provided for normally inserting signal intensity reducing means at some convenient point in the transmitting circuit of a station, said intensity reducing means being automatically short-circuited by means operated by the voice or the like to be transmitted.

The invention is illustrated in the diagrammatic drawings accompanying the specification.

In these drawings:

Figure 1 shows a general wiring scheme of a transmitting station adapted to put a subscriber at the end of, say, a land line, into communication with a distant correspondent over a radio channel. The invention is not limited to such application, of course, but its most general use will be found to lie in long distance, e. g. transoceanic, radio telephony.

Figure 2 shows diagrammatically an arrangement for normally inserting a signal intensity reducing means in the transmitting circuit of the station. In this figure only parts of Figure 1 are shown which are necessary for an understanding of the operation of the said normally inserted means.

Figure 3 shows a modification of the arrangement illustrated in Figure 1 of the drawings designed to avoid certain defects.

The station represented in Figure 1 of the drawings may be regarded as comprising five sets of apparatus indicated by chain line rectangles A B C D E. A is a hybrid coils set with balance network and serves to associate the two wire line 1 leading to the local subscriber with the receiving amplifier B (whose input is connected through leads 2 to the radio receiver) and the radio transmitting land line amplifier C (whose output is connected through leads 3 to the radio transmitter). D is a blocking device controlled by the signals in the amplifier B, and serving to "cut out" the amplifier C, while E is a blocking device controlled by the signals in the amplifier C and serving to "cut out" the amplifier B. The hybrid coils set is of usual kind, and comprises differential coupling coils L_1 and condensers K_1 K_2 K_3 K_4 and balancing network BN. It will be appreciated that if the hybrid coils set and balance network are "perfect" i. e. comply completely with theoretical requirements, and the arrangement is such that there is no out-of-balance and no reflection, current from the amplifier B could not find its way to the amplifier C. In practice, however, theoretical perfection is not attained, and is not likely to be, with the result that the well known phenomena of "echo", "singing" and increase in "noise level" occur.

The principal object of the present invention is to overcome these defects in a simple and satisfactory manner.

The leads 2 from the radio receiver are connected to an attenuating network AN, whose output terminals are connected across the input transformer Tr_1, of the amplifier B. The secondary of the transformer Tr_1, which is connected between grid and filament of an amplifying tube or valve V_1, is shunted by the usual adjusting resistance R_1, the arrangement being proportioned in accordance with well known principles, to secure absence of reflection and most efficient transmission in lines 2. The direct current and alternating current components of output from the tube or valve V_1 are separated by means of the choke Ch_1 and condenser C_1, so that alternating current only is fed to the primary of transformer Tr_2 which primary is adapted to be short-circuited in manner to be described later by means of the relay RL'

incorporated in the blocking device E. It will be seen that owing to the absence of direct current from the windings of transformer Tr_2, no substantial "clicks" or input or output impedance changes will occur when said transformer is short-circuited to cut out the amplifier B. The secondary of transformer Tr_2 actuates the parallel connected grid circuit of two thermionic tubes or valves Vc_1 Vc_2, the latter of which constitutes a second amplification stage and feeds the lines 1 via output transformer Tr_3, and the hybrid coils set, while the former serves as a coupling valve to the blocking device D, to whose input the plate of valve Vc_1 is connected through a sensitivity adjusting potentiometer P_1 and transformer Tr_4. Ch_3 and Ch_2 are chokes in series in the anode feed, while C_2 is a condenser in shunt across the source of anode potential (not shown). The advantages of employing the coupling valve are (1) that reaction from the blocking device D into the amplifier B is avoided, and (2) that an adjustment of the attenuating network to give the required received signal strength at the hybrid coils automatically effects adjustment of the strength required for correct working of the blocking device D.

The transformer Tr_4 is connected to the grid circuit of an amplifying valve V_3 whose plate circuit includes a more or less flatly tuned resonant circuit L_4 C_4 (tuned to, say, 1200 cycles) which serves to render the blocking device D less sensitive at "noise level" than at speech frequencies. The output from the valve V_3 is coupled by means of a condenser C_5 and resistance R_2 to the grid circuit of a further amplifying tube or valve V_4 whose output is in turn coupled through transformer Tr_5 to the input side of a valve V_5 which is connected, as shown, to operate after the manner of a so-called Fleming rectifier valve. This arrangement has two advantages:—(1) that the need for separate anode batteries is avoided, and (2) that the whole device is stabilized by the avoidance of reaction through the anode batteries. The alternating current component is bypassed by means of the condenser C_7, while the direct current component, due to rectification, is utilized to build up a voltage across the resistance R_3 which voltage tends to oppose the positive grid bias, due to a battery E_F and is applied to the grid of the valve V_6. R_4 is an adjustable resistance and C_8 a condenser, the said parts R_4 and C_8 serving in conjunction with condenser C_7 and a biasing of one of the windings of the relay RL to secure rapid closing and delayed opening of said relay in manner later to be described. The effect of the current passing through the resistance R_3 will be to reduce the plate current through the valve V_6 and, under normal speech strength, this current will be reduced to zero.

The relay RL, which is of the high speed type and adjusted for great sensitivity and neutral mechanical bias, comprises differential windings, one of which serves as a biasing winding and the other of which is connected in the plate circuit of valve V_6. The biasing current is obtained from the battery ER (which may be the filament battery) and is adjusted by means of resistance R_5 so that the steady biasing current is nearly equal to the steady plate current of the valve V_6, which current may be adjusted by means of the grid bias battery E_F. This results in that the relay tongue will change contact for a very small decrease of the valve plate current, and the lapse of time for "blocking" the amplifier C will be very small. By decreasing the biasing current this lapse of time may be increased.

The discharge of condensers C_7 and C_8 is dependent upon the value of the resistance R_4 and controls the return of the plate current of the valve V_4 to normal condition, and therefore indirectly controls the lapse of time required for releasing the "blocking" of the amplifier C.

The time adjustments should be such that "blocking" is effected almost at once, while "release of blocking" is effected rather sluggishly so that such release does not occur between, say, syllables.

Z is a lamp which is illuminated (as will be seen from the diagram) when the relay RL is not "blocking" the amplifier C, i. e. when the distant correspondent is not talking.

The blocking device E is actuated by current fed to it throught the potentiometer P'_1 from the coupling valve Vc'_1 in the transmitting amplifier C and serves, when actuated, to block the receiving amplifier B by short-circuiting the primary of the tarnsformer Tr_2. It will be seen that the blocking devices D and E are similar in general arrangement as are the amplifiers B and C, and further description of the parts C and E is therefore thought unnecessary. As will be obvious from Figure 1 of the drawings, the blocking device E can only be actuated by currents reaching the amplifier C from the local subscriber through the hybrid coils set, i. e. when the local subscriber is talking. MN is an attenuating network and may take the form of a "monitoring pad", i. e. a pad of adjustable attenuating impedances (generally under manual control), serving to maintain the strength of the signals within predetermined limits.

Referring to Figure 2, it will be seen that resistances R'_6 are inserted in series with the lamps ZZ' and that across these resistances are shunted the windings WW' of auxiliary relays AR, AR'. The armatures of these relays are connected together and to one end of the winding W_3 of a third auxiliary relay AR_3, the other end of said winding being connected as shown through a battery to those contacts of the relays AR, AR' with which their armatures contact when they are de-energized. Thus, if either winding W or W' release its armature, winding W_3 is energized. The relay AR_3 actuates four switch devices S_1 S_2 S_3 S_4, the arrangement being such that the relay armature in moving to "energized" position, closes switches S_1 S_3 S_4 and opens switch S_2. Switches S_1 S_2 S_3 are associated as shown with a signal attenuating pad SP which is inserted in the lines 3 and may be of a value of, say, 20 T. U.

CR constitutes a delaying circuit which is shunted across the winding W_3 when switch S_4 is closed.

The operation is as follows:—

Suppose neither the local subscriber nor his distant correspondent is speaking. Both lamps Z and Z' will be energized, both relays AR, AR' will be energized, relay AR_3 will be de-energized, switches S_1, S_3, S_4 will be open, and switch S_2 will be closed. None of the amplifiers will be blocked and the complete communication circuit comprising home hybrid coils set, home transmitter, radio channel, distant receiver, distant hybrid coils set, distant transmitter, radio channel, home receiver, home hybrid coils set will include a signal weakening means of 40 T. U., due to the insertion of 20 T. U. at the home station and 20 T. U. at the distant station, which is similar. As soon as the home subscriber or

his correspondent speaks, however, relay AR_3 is energized (through the action of relay AR or AR' under the control of relay RL or RL'), the pads SP (at home and distant stations) are short-circuited, and the delay circuits CR are connected across the windings of relay AR_3 (at home and distant stations). When talking ceases, the relays AR_3 return to de-energized position after a short delay, due to the action of the circuits CR. The purpose of this delay is to prevent the reinsertion of a pad SP in a brief interval which may occur between message and answer or vice versa; in other words, if relay AR^3 has been energized by the release of relay AR, and will be energized almost immediately after by the relay AR', the delay circuit CR will hold relay AR_3 in energized position for a length of time sufficient to enable the function of maintaining said relay AR_3 energized to be transferred from relay AR to relay AR'. Thus relay AR_3 will not be released at all for the short pauses of ordinary conversation.

The short-circuiting of the pads SP will not be instantaneous upon commencement of a message, with the result that part of the opening syllable may be lost. This, however, is not of any practical importance.

The pads SP are, of course, of such value as to prevent the total gain of the amplifier overcoming the losses in the complete communication circuit, and thus said pads serve to prevent "singing round the circuit" when no one is speaking.

A defect present in the arrangement thus described is that when the amplifier C (Figure 1 of the drawings) is adjusted to give a large "gain" in order to bring up feeble speech to the normal level, the unbalanced speech current amplified by the transmitting amplifier C reaches the blocking devices E at the same time speech current reaches D, thus causing a momentary false working of the relay RL of device E at each initial part of the speech received. The circuit of Figure 3 is adapted to avoid this defect.

In Figure 3 the grid of the valve or tube V'_3 of the device E is not connected (through the secondary of transformer Tr'_4) to earth as in the arrangement shown in Figure 1 of the drawings, but is connected through the said transformer secondary and a bias battery IB to the upper end of the resistance R_3 in the device D. The battery IB is of such voltage that the valve V'_3 operates at the same point of its characteristic as in the arrangement of Figure 1 of the drawings.

It will be seen that in this modification, when speech current reaches the circuit C_7 R_4 C_8 of the device D, it instantly blocks by strongly biasing negatively the grid circuit of the valve V'_3 in the device E, thus operating in advance the mechanical relay RL of the blocking device D, performing indirectly the same thing. In this way an interlocking operation of the two blocking devices is obtained. When no speech current is received the tongue of the relay RL touches its left hand contact and lights the lamp Z, while when speech current is received the said relay tongue moves over to its other contact, switching off the lamp Z and short-circuiting the primary of the transformer Tr'_2.

Having now described my invention what I claim is:—

1. In a signalling system, a transmitting channel and a receiving channel, transmitting apparatus connected in said transmitting channel and receiving apparatus connected in said receiving channel, means operable upon reception of signals in the receiving channel for rendering the transmitting channel inoperative, means in the transmitting channel responsive to signals to be transmitted for rendering said receiving channel inoperative, a signal attenuating means normally connected in one of said channels to prevent singing therein when no signals are present in either of said channels, and a circuit connected with said first and said second named means and actuated by signals in either of said channels to short-circuit said signal attenuating means.

2. In a two-way signalling system, a transmitting channel and a receiving channel, means for amplifying signals received in said receiving channel comprising an amplifying tube, means for amplifying in said transmitting channel signals to be transmitted, means responsive to received signalling oscillations for rendering said transmitting channel inoperative, and means operable upon signalling impulses for transmission being placed in said transmitting channel for rendering said receiving channel inoperative, a signal attenuating network normally connected in one of said channels, and means provided by a coupling tube connected in said receiving channel in parallel with the amplifier for preventing reaction of the transmitting channel disabling means upon the receiver amplifier and for permitting the adjustment of the attenuating network to give the required received signal strength.

3. In a two-way signalling system, a transmitting channel and a receiving channel, signal amplifying means in said receiving channel for amplifying received signalling oscillations, signal amplifying means in said transmission channel for amplifying signalling oscillations for transmission, a disabling circuit connected between said receiving and transmitting channels for disabling said transmitting channel upon receipt of signalling oscillations in said receiving channel, and a disabling channel connected between said transmitting and said receiving channel for disabling said receiving channel during periods when signals are transmitted through said transmitting channel, means associated with each of said disabling circuits for limiting the response thereof to supplied signals of predetermined signal intensity impressed thereon, an attenuating network, and a circuit connected with both of said disabling circuits and with said attenuating network and responsive to the absence of signal currents in both of said channels for connecting said attenuating network with one of said channels.

4. In a four-wire signalling system comprising a two-wire branch having transmitting apparatus associated therewith and a second two-wire branch having receiving apparatus associated therewith, means to interconnect said branches, means rendering one branch operative for transmission and the other branch inoperative for reception, and means responsive to received signals for rendering said operative branch inoperative for transmission and the inoperative branch operative for reception, each of said means comprising a blocking device including thermionic amplifiers having their input electrodes resistively connected to a different one of said branches and their output electrodes coupled to a device for completing a circuit in parallel with the other of said branches, one of said

amplifiers also having its input electrode conductively connected through a source of biasing potential to a point in the circuit of the other amplifier, whereby interlocking of said branches by way of said amplifiers is effected.

5. In a radio system for two-wire communication, a transmitting channel and a receiving channel each comprising a plurality of vacuum tube amplifiers, a plurality of blocking devices interconnecting said transmitting and receiving channels for rendering said transmitting channel inoperative during periods when said receiving channel is operative and said receiving channel inoperative at periods when said transmitting channel is operative, means for adjusting the sensitivity of response of each of said blocking devices, a rectifier device included in each of said blocking devices, capacity and resistance means responsive to the output energy from said rectifying device for initially causing one of said channels to be rendered inoperative upon the passage of signalling impulses through the other of said channels, and resistance means for delaying the period for normally rendering said disabled channel operative upon a cessation of signalling impulses in the channel originally operative.

6. A signalling system to be used with a subscriber's station comprising, an incoming line, an outgoing line, a balancing network connecting said lines to said subscriber's station to substantially confine the incoming signals and the outgoing signals to their proper lines, an amplifier in each line, each of said amplifiers including thermionic repeaters in cascade, means for further insuring that the incoming signals and the outgoing signals are confined to their proper lines by blocking one of said amplifiers and rendering the same inoperative when signals are impressed on the other of said amplifiers and vice versa including, a pair of thermionic coupling devices interconnecting said amplifiers, each of said coupling devices including a thermionic coupling tube having its input electrodes variably coupled to one of said amplifiers and its output electrodes connected with a device for completing a circuit in parallel with the other of said amplifiers for controlling the effectiveness of the same to amplify signals, and means for preventing singing in said system including said incoming and said outgoing lines and balancing network comprising, an attenuation network, and circuits connecting both of said coupling devices with said attenuation network and responsive to currents in either of said coupling devices for inserting said attenuation network in one of said lines when no currents flow in either of said lines.

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