Oct. 28, 1924. 1,513,452

L. ESPENSCHIED

HALF DUPLEX MORSE CARRIER SYSTEM

Filed Aug. 11, 1921 3 Sheets-Sheet 1

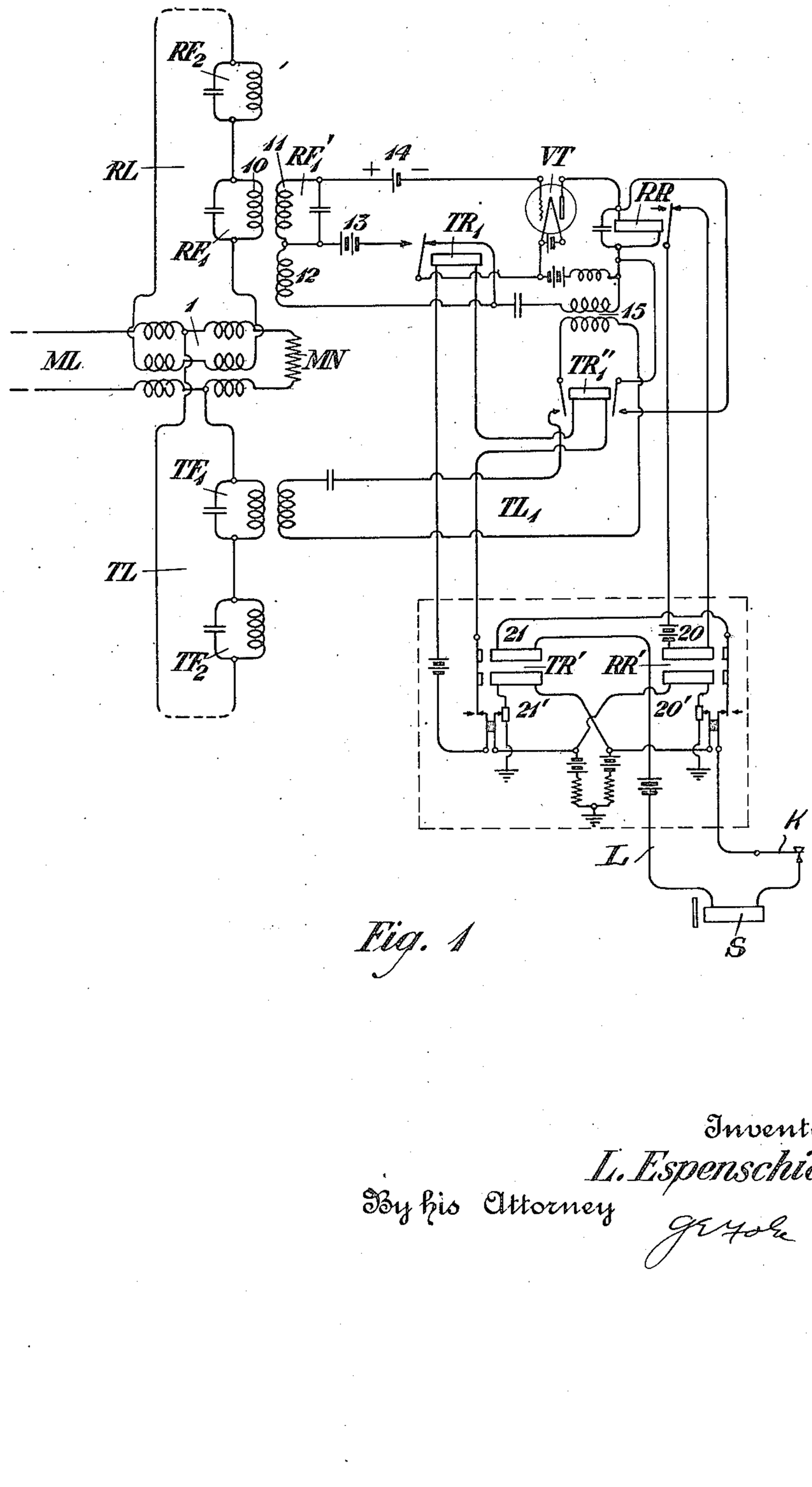

Fig. 1

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Filed Aug. 11, 1921 3 Sheets-Sheet 2

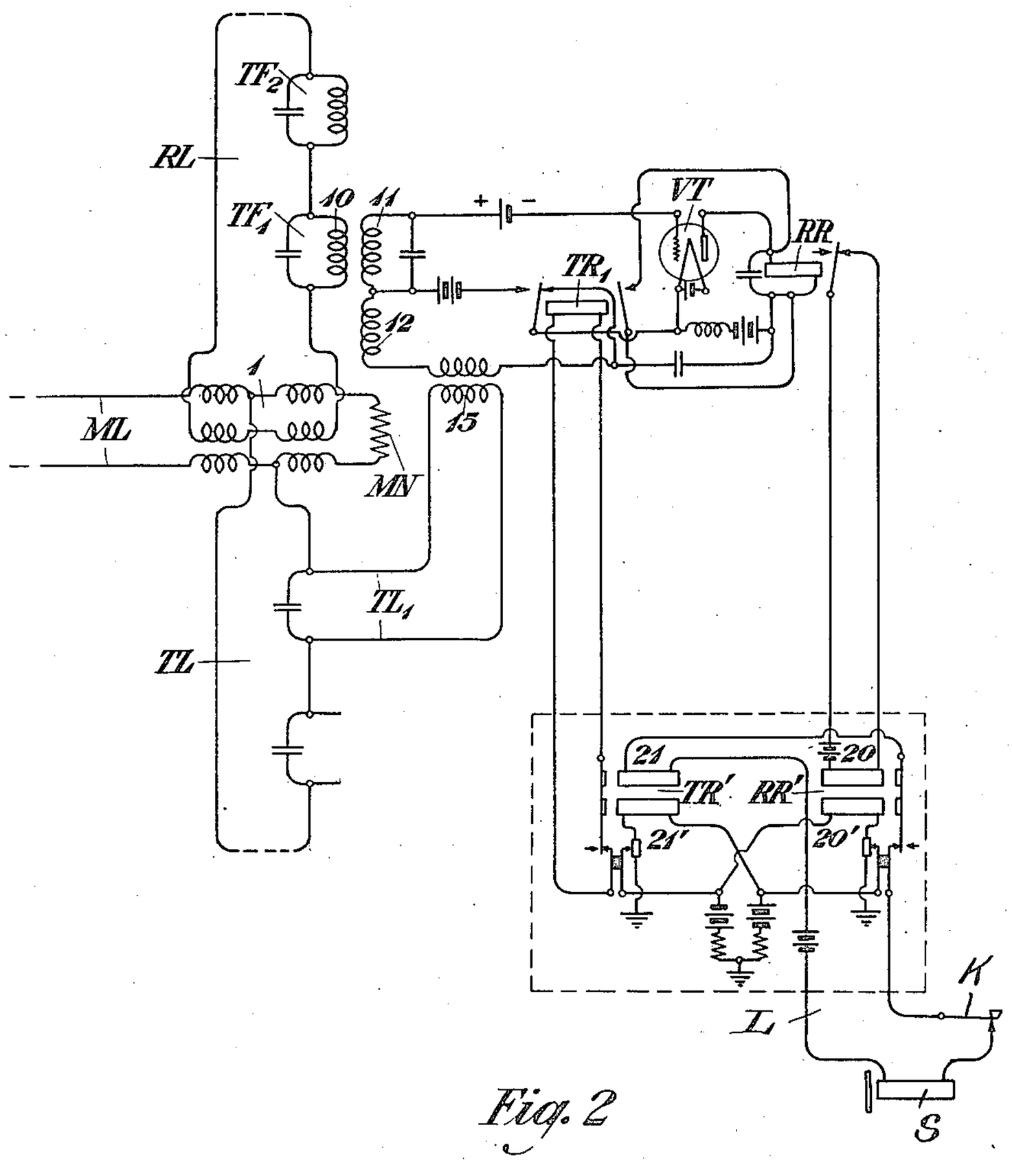

Fig. 2

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Filed Aug. 11, 1921 3 Sheets-Sheet 3

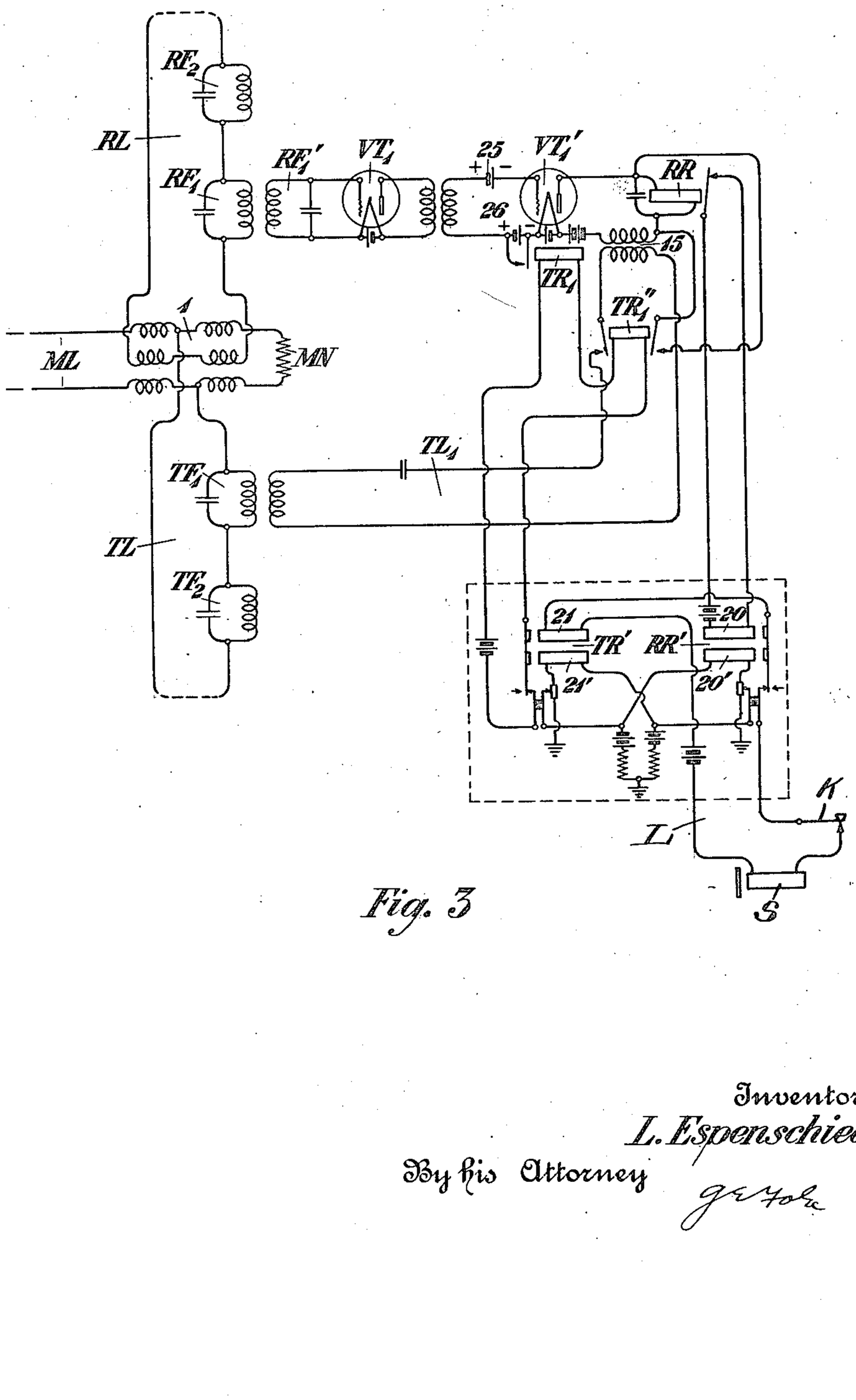

Fig. 3

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Patented Oct. 28, 1924. 1,513,452

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

HALF-DUPLEX MORSE CARRIER SYSTEM.

Application filed August 11, 1921. Serial No. 491,511.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Queens, in the county of Queens and State of New York, have invented certain Improvements in Half-Duplex Morse Carrier Systems, of which the following is a specification.

This invention relates to signaling systems, and more particularly to multiplex signaling systems employing carrier currents for transmission purposes.

One of the purposes of this invention is to produce a simple terminal apparatus for half-duplex Morse operation over carrier channels. In order to simplify the terminal apparatus in accordance with the present invention, it is proposed to use the same vacuum tube as a detector when receiving and as an oscillator when transmitting. A salient feature of the terminal arrangement involves the association of the vacuum tube with the transmission circuit through a balanced circuit arrangement involving a hybrid coil and two channels, one channel being used for transmitting and the other for receiving. This permits the tube when functioning as a detector to receive oscillations through the receiving channel, and when functioning as an oscillator to transmit oscillations to the transmission circuit over the transmitting channel.

Other and further features of the invention will be clear from the following description, when read in connection with the accompanying drawing, the three figures of which illustrate different circuit arrangements embodying the principles of the invention.

Referring to Figure 1, ML designates a main transmission line having associated therewith a transmitting circuit TL and a receiving circuit RL, these circuits being associated with the main line through the usual hybrid coil 1, and being rendered substantially conjugate by means of a balancing circuit MN for simulating the impedance of the main line. The receiving circuit RL includes a plurality of selective circuits F_1, F_2, etc., these selective circuits being adapted to associate the receiving circuit with the vacuum tube device of the terminal apparatus. The vacuum tube and associated circuits connected with but one of the selective devices is illustrated, but it will be understood that similar apparatus will be provided for each channel. The apparatus associated with the selective device RF_1 includes a vacuum tube VT of the usual three-element type. A tuned circuit or other selective device RF_1' is included in the grid circuit of the vacuum tube. This tuned circuit is coupled with the tuned circuit or selective device RF_1 and renders the vacuum tube selective of the received carrier frequency when receiving and serves to determine the frequency of the vacuum tube when functioning as an oscillator, as will be described later. The output circuit of the vacuum tube VT includes a receiving relay RR for controlling the circuit of an operating magnet 20 of a loop controlling relay RR', so that a sounder S in the loop L will be actuated in response to detected signals. The relay RR' constitutes part of the mechanical repeating apparatus for associating the loop with the vacuum tube circuit, so that signals may be transmitted to and from the loop, as will be described later.

The tuned circuits RF_1 and RF_1' are coupled together through windings 10 and 11 of a transformer, and a third winding 12, arranged in inductive relation to the windings 10 and 11, is connected to the plate circuit. A transmitting relay TR_1 is provided for controlling the circuits of the vacuum tube. This relay is normally energized and when in this condition establishes a connection from the filament of the vacuum tube VT through the windings 12 and 11 in series to the grid of the tube. Under these conditions, the tube functions as a simple detector. When the transmitting relay is deenergized, the connection from the filament of the tube is shifted so that it is extended to the junction point between the windings 11 and 12. The winding 12 is now in the plate circuit and the winding 11 in the grid circuit, so that a feed-back coupling is established to permit the tube to oscillate. An auxiliary battery 13 is included in this connection in series with the normal grid battery 14 to change the grid potential to such a value as to render the tube efficient as an oscillator. The plate circuit includes a transformer 15 for associating the output circuit of the vacuum tube when functioning as an oscillator with a tuned circuit TF_1 in the transmitting circuit TL, this associa-

tion being effected through the transmitting channel TL_1. The transmitting channel TL_1 is normally held open by means of a relay TR_1'' which is included in circuit with the transmitting relay TR_1 and is normally energized. When the relay TR_1 is deenergized to change the vacuum tube circuits to the oscillating condition, the relay TR_1'' is also deenergized to complete the connection through the transmitting channel TL_1. This channel is held open under receiving conditions to prevent signals received by the tube from being transmitted back to the main line. The relay TR_1 is also arranged to short circuit the receiving relay RR to prevent it from responding to oscillations.

The transmitting relay TR_1 and its associated relay TR_1'' are controlled by means of a loop transmitting relay TR′ whose operating magnet 21 is included in the normally closed loop circuit L. The loop controlling relay RR′ has its armature arranged to open and close the loop circuit, and these, and the two relays TR′ and RR′ together constitute the mechanical repeating arrangement hereinbefore referred to for associating the loop with the vacuum tube arrangement. These relays are provided with auxiliary holding magnets 21′ and 20′, respectively, for preventing false operation of the relays, as will be described later. Each of these magnets is normally short-circuited, the magnet 21′ being short-circuited over the contact of the relay RR′ and the magnet 20′ being short-circuited over the contact of the relay TR′.

Under normal conditions, the loop L is closed so that the relay TR′ is energized to maintain the circuits of the transmitting relay TR_1 and the associated relay TR_1'' closed. The transmitting channel TL_1 is, therefore, held open and the circuits of the vacuum tube are maintained in such relation by the relay TR_1 that the tube functions as a simple detector as already described. Oscillations incoming over the main line ML are, therefore, transmitted through the tuned circuit RF_1 to the grid circuit of the tube VT, and the signals detected by the tube actuate the receiving relay RR to open the circuit of the operating magnet 20 of the relay RR_1. As the holding magnet 20′ of this relay is normally short-circuited, the armature of the relay RR′ is permitted to fall off, thereby opening the loop circuit and causing the sounder S to respond. This operation deenergizes the operating winding 21 of the relay TR′, but since the short-circuit controlled by the contacts of the relay RR′ is removed from about the holding magnet 21′ at the same time that the loop circuit is opened, the armature of the relay TR′ is prevented from falling off to repeat the signals back to the main line ML.

When it is desired to transmit signals from the loop L to the main line, the key K may be actuated to open the loop, thereby deenergizing the operating magnet 21 of the relay TR′. As the holding magnet 21′ is short-circuited, the armature of the relay is permitted to fall off, thereby opening the circuit of the transmitting relay TR_1 and the associated relay TR_1''. The deenergization of the relay TR_1 shifts the connections of the vacuum tube from detecting condition to oscillating condition and short-circuits relay RR. The relay TR_1'' at the same time closes the transmitting channel TL_1 so that the oscillations generated by the vacuum tube VT are transmitted through the transformer 15 over the channel TL_1 through the selecting circuit TF_1, and over the transmitting circuit TL to the main line ML. The armature of the relay TR′, in falling off, removes the short-circuit from about the auxiliary magnet 20′ of the relay RR′ and prevents false operation of said relay in case the receiving relay RR should respond to the transmitted signals. Such response is prevented by the short-circuiting of relay RR as previously described.

A slightly modified arrangement of the apparatus is illustrated in Fig. 2. In this case the relay TR′ is arranged to shift the connection from the filament in the same manner as described in connection with Fig. 1 in order to change the vacuum tube VT from a detector to an oscillator. The transformer 15, for associating the oscillating output circuit of the tube with the transmitting circuit TL over the transmitting channel TL_1, is, in this instance, included in the grid side of the vacuum tube circuit when arranged for detector operation, rather than in the plate side as shown in Fig. 1. No arrangement is provided for opening the transmitting channel TL_1 when the circuit is thus connected, and the inductance of the transformer 15 is permitted to cooperate with the capacity in the transmitting circuit TL to constitute a tuned selecting device. It is unnecessary to open the transmitting channel TL_1 during receiving conditions, for the reason that if the transmitting and receiving circuits TL and RL are properly balanced, the high frequency energy incoming over the main line ML will divide equally between these two circuits, and the energy transmitted through the selecting circuit TF_1 to the input circuit of the vacuum tube VT will be balanced, so far as its tendency to be transmitted through the transformer 15 is concerned, by the normal energy transmitted into the channel TL_1. The energy is not balanced as regards the input circuit of the vacuum tube VT, however, and the vacuum tube functions to detect signals from the high frequency energy. In transmitting, the transmitting relay TR_1 will be deenergized in a manner previously de-

scribed, thereby changing the circuit conditions of the tube so as to render the tube oscillatory. The oscillations thus set up will be transmitted through the transformer 15 and over the channel TL_1 to the main line ML. The energy thus transmitted to the main line is prevented from reacting in the receiving circuit RL by means of the hybrid coil 1 and the balancing network MN.

Fig. 3 illustrates an arrangement in which the oscillations are set up by the vacuum tube arrangement through the unbalanced condition existing between the transmitting and receiving circuits TL and RL. While normally these circuits are sufficiently well balanced so that the transmission over the circuit TL to the receiving circuit RL may be considered negligible, in some instances a considerable degree of unbalance exists and this may be utilized in the generation of oscillations. The vacuum tube apparatus in this instance comprises two tubes, a tube VT_1 which functions as an amplifier and a tube VT_1' which normally will function as a detector. A receiving relay RR is included in the output circuit of the tube VT_1' and its grid circuit includes polarizing batteries 25 and 26. The latter battery is arranged to be short-circuited by the contact of the transmitting relay TR_1 when said relay is deenergized. When both batteries are effectively in series in the grid circuit, the potential upon the grid will be such that the tube is efficient as a detector, but when the transmitting relay TR_1 is deenergized in transmitting signals, the short-circuiting of the battery 26 results in such a change of the grid potential that the tube is efficient for amplifying or oscillating. An auxiliary relay TR_1'' is associated with the transmitting relay TR_1 for holding open the transmitting channel TL_1, which is coupled with the output circuit of the tube VT_1' through the transformer 15.

Under normal conditions, the transmitting channel TL_1 is held open so that received oscillations from the main line ML pass into the receiving circuit and are selected by means of the tuned circuit RF_1 and RF_1' into the input circuit of the amplifying tube VT_1. The oscillations are then amplified and impressed upon the grid circuit of the tube VT_1' which, by reason of the fact that the battery 26 is short-circuited, operates as a detector, so that the detected signals actuate the receiving relay RR and are repeated into the loop by means of the repeating apparatus as described in connection with Fig. 1. When signals are transmitted from the loop, the repeating apparatus operates as already described, to deenergize the relays TR_1 and TR_1''. The former relay short-circuits the battery 26 to change the potential of the grid of the tube VT_1, so that it will be efficient as an oscillator. The relay TR_1'' closes the transmitting channel TL_1. Consequently, the energy from the output circuit of the vacuum tube VT_1' is transmitted over the channel TL_1 into the transmitting circuit TL to the line ML. As a portion of this energy passes into the receiving circuit RL due to the unbalance between the transmitting and receiving circuit, the unbalanced energy is permitted to react upon the grid circuit of the vacuum tube VT_1 through the selecting circuits RF_1 and RF_1'. This energy is amplified by the vacuum tube VT_1 and impressed upon the vacuum tube VT_1', where it is again amplified and passes into the circuit TL_1. It will thus be seen that a singing circuit is established, so that the oscillations generated will pass to the main line ML whenever the key K is actuated to open the loop.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a transmitting circuit and a receiving circuit substantially conjugate with respect to each other, and a vacuum tube associated with said transmitting circuit and said receiving circuit, said vacuum tube functioning under certain conditions as a detector, and under other conditions as a generator of oscillations.

2. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a transmitting circuit and a receiving circuit substantially conjugate with respect to each other, a vacuum tube associated with said transmitting circuit and said receiving circuit, and connections whereby under certain conditions said vacuum tube functions to detect signals from the carrier currents transmitted from said transmission circuit over said receiving circuit to said vacuum tube, and whereby under other conditions said vacuum tube functions to generate oscillations for transmission over said transmitting circuit to said transmission circuit.

3. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a transmitting circuit and a receiving circuit substantially conjugate with respect to each other, a translating device associated with said transmitting and receiving circuits, and circuits for said translating device including switching means, said switching means being so arranged that under certain conditions the translating device func-

tions as a detector and under other conditions functions as a generator of oscillations, and a local subscriber's loop and mechanical repeating apparatus for interconnecting said local subscriber's loop with said translating device, said repeating apparatus including means for repeating signals detected by said translating device to said loop, said repeating apparatus also including means responsive to signals originating in the loop to control said switching means to cause said translating device to generate oscillations.

4. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a transmitting circuit and a receiving circuit substantially conjugate with respect to each other, a vacuum tube associated with said transmitting and receiving circuits and circuits for said vacuum tube including switching means, said switching means being so arranged that under certain conditions the vacuum tube functions as a detector and under other conditions functions as a generator of oscillations, and a local subscriber's loop and mechanical repeating apparatus for interconnecting said local subscriber's loop with said vacuum tube, said repeating apparatus including means for repeating signals detected by said vacuum tube to said loop, said repeating apparatus also including means responsive to signals originating in the loop to control said switching means to cause said vacuum tube to generate oscillations.

5. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a translating device, circuits for said translating device so arranged that under certain conditions it functions as a detector and under other conditions it functions as a generator of oscillations, a transmitting circuit and a receiving circuit for interconnecting said translating device to said transmission circuit, said transmitting and receiving circuits being substantially conjugate with respect to each other, a subscriber's loop and mechanical repeating apparatus for associating said subscriber's loop with said translating device, means for normally holding open said transmitting circuit, said repeating apparatus comprising means whereby when said translating device functions as a detector, the detected signals may be repeated to said loop, said repeating apparatus also including means responsive to signals originating in said loop for closing said transmitting circuit and adjusting the circuits of said translating device so that it generates oscillations for transmission over said transmitting circuit to said transmission circuit.

6. In a signaling system, a transmission circuit and carrier apparatus associated therewith, said carrier apparatus including a vacuum tube, circuits for said vacuum tube so arranged that under certain conditions it functions as a detector and under other conditions it functions as a generator of oscillations, a transmitting circuit and a receiving circuit for interconnecting said vacuum tube to said transmission circuit, said transmitting and receiving circuits being substantially conjugate with respect to each other, a subscriber's loop and mechanical repeating apparatus for associating said subscriber's loop with said vacuum tube, means for normally holding open said transmitting circuit, said repeating apparatus comprising means whereby when said vacuum tube functions as a detector, the detected signals may be repeated to said loop, said repeating apparatus also including means responsive to signals originating in said loop for closing said transmitting circuit and adjusting the circuits of said vacuum tube so that it generates oscillations for transmission over said transmitting circuit to said transmission circuit.

In testimony whereof, I have signed my name to this specification this 9th day of August, 1921.

LLOYD ESPENSCHIED.