July 26, 1949. O. TSCHUMI 2,477,275

VOICE-CONTROLLED TWO-WAY COMMUNICATION SYSTEM

Filed Jan. 20, 1945 2 Sheets-Sheet 1

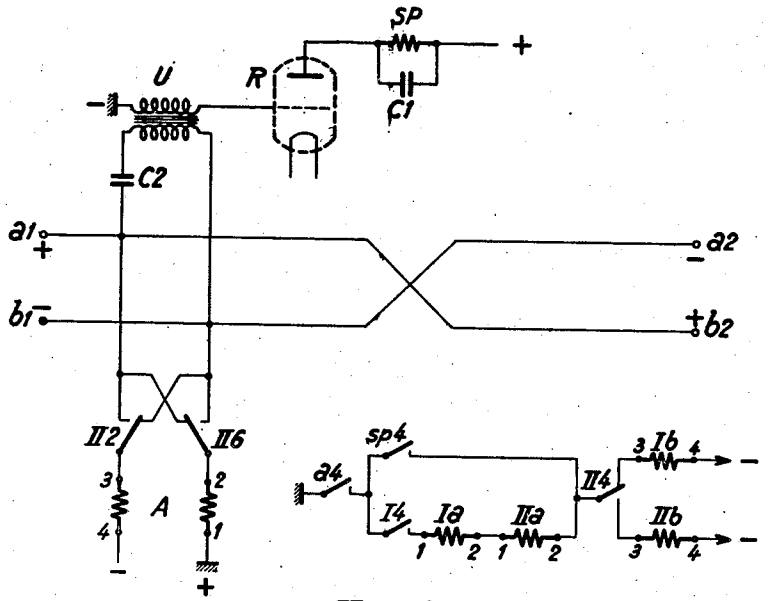


Fig. 1.

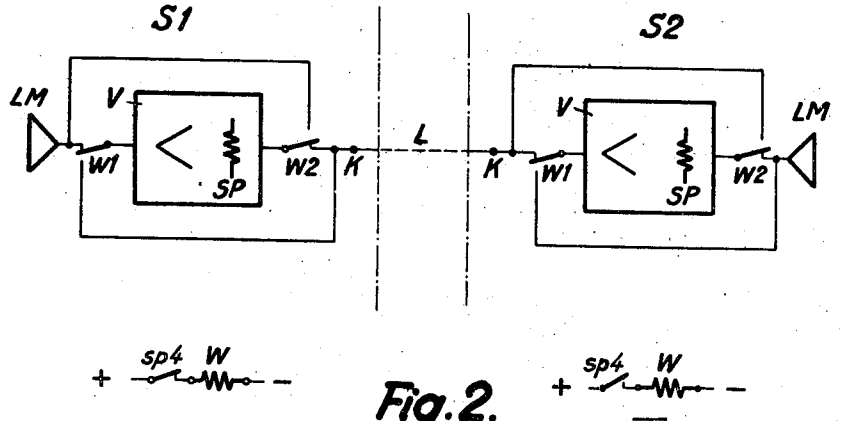


Fig. 2.

Inventor
O. Tschumi
By Hauck Downing & Lee
Attys

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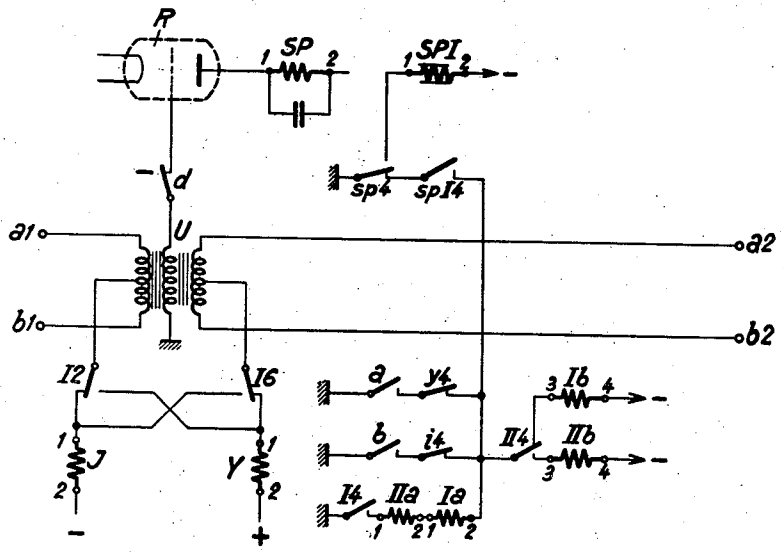


Fig.3.

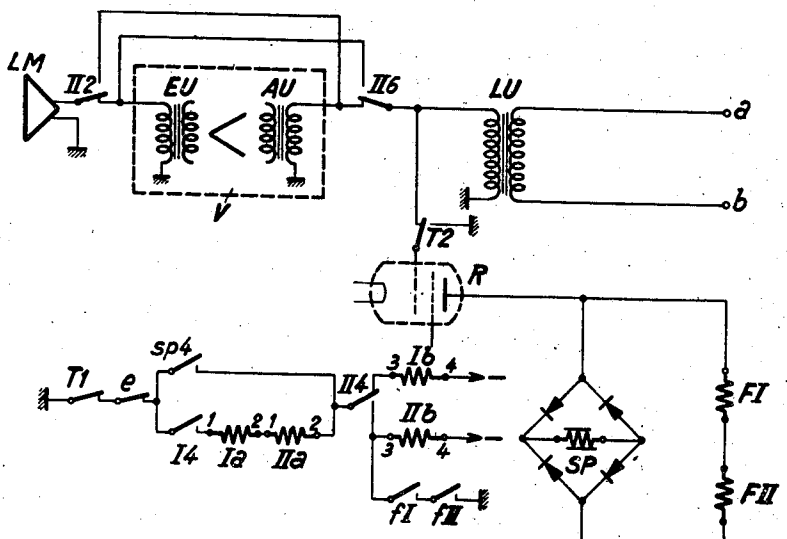


Fig.4.

Inventor
O. Tschumi
By Glenn Downing Riecke
Attys

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UNITED STATES PATENT OFFICE

2,477,275

VOICE-CONTROLLED TWO-WAY COMMUNICATION SYSTEM

Otto Tschumi, Soleure, Switzerland, assignor to the firm Autophon Aktiengesellschaft, Soleure, Switzerland, a joint-stock company of Switzerland

Application January 20, 1945, Serial No. 573,693
In Switzerland January 15, 1944

7 Claims. (Cl. 179—1)

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The invention relates to improvements in telephone systems for the transmission of voice signal current alternately in either direction and especially to systems of the type in which the direction of transmission is voice controlled.

Telephone systems in which the speaking direction can be changed by means of speech signals are well-known in the art. In some of these systems the first voice signal of a speech train serve for control purposes and are consequently lost from the conversation. This disadvantage cannot be removed by making the control means more sensitive because the whole voice control system is then too exposed to disturbances.

The object of the invention is to provide a voice control telephone system for transmission of voice signal current alternately in either direction, wherein from the beginning of the first voice signal the whole speech train is transmitted uninterruptedly, that is wherein no voice signals are clipped from the speech train for control purposes. To attain this the control means according to the invention operates in such a way that the reversal of the direction of transmission is prepared during the transmission of the speech train and is carried out a predetermined time after cessation of this speech train. Because of the provided time delay no reversal is carried out following the short interruptions occurring in normal conversation.

A feature of the invention is to provide a telephone system of the kind mentioned wherein the voice control means is combined with a manually operable control means for the reversing of the direction of transmission.

Other features and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings illustrating by way of example different embodiments of the telephone system according to the invention and in which like numerals are employed to designate like parts throughout the same,

Figure 1 shows an embodiment in which the control means according to the invention is arranged anywhere on the channel for transmitting the voice signal current connecting two subscribers either directly or by way of inter-connection devices;

Figure 2 shows an embodiment in which the control means are arranged at each subscriber station;

Figure 3 shows an embodiment having further control means for reversing the direction of transmission, and

Figure 4 shows the essential parts of another

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embodiment in which further control means are arranged permitting a subscriber to choose the speaking direction without regard to the existing operating condition.

Referring now to Figure 1, the conductor pairs a_1, b_1, and a_2, b_2, forming the transmission channel connect the voice control means with the two subscriber stations. The voltage conditions are chosen so that opposite designated terminals have always the same potential (a_1 and b_2; a_2 and b_1). However, the polarity changes according to which station is adjusted to "speaking."

On the one side a rectifier arrangement and, on the other side, the real reversal means are disposed at any place along these conductor pairs. The rectifier arrangement consists substantially of a direct current blocking condenser C2 to which the primary winding of transformer U is connected to the conductor pairs. The other winding is grounded at one end while the other end is connected to the grid of a rectifier tube R. The reversal means includes a relay A having two coils (A_{1-2} and A_{3-4}) connected to different poles of a suitable electrical source and to the one or the other of the conductors according to the position of switches II_2 and II_6. These two coils are arranged on the same core (not shown) and operate a switch a_4, that is switch a_4 is closed when one of the coils of relay A is energized.

An auxiliary control circuit for controlling the reversing switches to II_2, II_6, includes two relays I and II, each having two coils (I*a*, I*b* and II*a*, II*b*, respectively) on a common core (not shown) operating on switch I_4 and switches II_4, II_2, II_6, respectively. Thus, switch I_4 is closed when current is fed through one or the other of the coils I*a* and I*b*, and switches II_2, II_6, II_4 are switched over from their positions as shown when current is fed through one or the other of the coils II*a* and II*b*. When both of the coils of these two relays I and II become currentless again, the respective switches fall back to their initial positions, as shown.

The auxiliary control circuit is connectable to ground by means of switch *a*4 and has two branches in parallel, one branch comprising in series switch I_4, coil I*a* of relay I and coil II*a* of relay II, and the other branch comprising a switch *sp*4 operated by a relay coil SP. The two parallel branches may be connected to either coil I*b* or coil II*b* and through these to the negative pole according to the position of switch II_4.

The rectifier tube R feeds the rectified speech signal current to the coil SP of a slow releasing relay connected to the anode of said tube, having

a by-pass condenser C1 connected across its terminals. The illustrated system operates as follows:

While the subscriber at terminals *a*1, *b*1 converses with the subscriber receiving the transmitted speech signals at terminals *a*2, *b*2, the terminals *a*1, *b*2 may be positive and the others, terminals *a*2, *b*1, may be negative, as shown. Under these conditions two separate circuits are closed through switches II_2 or II_6, respectively, and the corresponding coils A_{3-4} and A_{1-2} of relay A, which are energized and close the switch *a*4 in the auxiliary circuit. On the other hand the alternating current which is produced by the speech signals is applied to the grid of the rectifier tube R through the transformer U, thereby energizing releasing relay SP. The condenser C2 prevents any direct current short circuit of the condenser pair. The excited, slow releasing relay SP closes the switch *sp*4, so that a further circuit is closed through switches *a*4, *sp*4, II_4 and relay coil I_b. Relay I is thereby energized and closes switch I_4, thereby effecting the closing of a new circuit through relay coils I*a* and II*a*. However, as long as the slow operating relay SP is energized, the relay coils I*a* and II*a* are short-circuited by the switch *sp*4. The switch elements remain in this position as long as speech signals are uninterruptedly emitted in the said direction. When the transmission of speech signals is interrupted, the alternating current circuit is destroyed and the relay SP becomes de-energized after a delay period determined by the decay of the charge on the condenser C1. Within this delay time, that is before the relay SP is released, the conversation can be taken up again by the subscriber in question in the same direction without effecting the change-over process. In consequence, the speaking direction can not be reversed merely by an ordinary interruption in conversation, but the reversal is dependent on the expiration of a time period of such a duration that this pause may be considered as an invitation to the conversing party to answer. When the slow operating relay SP becomes de-energized, the switch *sp*4 is opened and the circuit, including switch I_4, coil I*a* of relay I, and coil II*a* of relay II is no longer short-circuited. Thus, relay II is excited by means of its coil II*a* and erects the switch-over of the reversing switches II_2 and II_6, and also of the switch II_4, so that a circuit is closed through the ground, switch *a*4, switch I_4, relay coil I*a*, relay coil II*a*, switch II_4, and relay coil II*b* to the negative pole of the source. The arrangement remains in this condition until the second subscriber, whose station is now adjusted to transmission, begins to speak. Relay SP is again excited and switch *sp*4 short-circuits relay coils I*a* and II*a*. The reversing switches II_2, II_6, and the switch II_4 are retained in the same position by the current flowing through relay coil II*b*; switch I_4, however, is opened as current is fed through neither of the coils I*a* and I*b* of relay I. At the end of the speech train of the second subscriber and after the delay time of the slow releasing relay SP, switch *sp*4 is opened, all auxiliary circuits are interrupted, and the relay coils II*a*, II*b* are de-energized whereby the switches II_2, II_6 and II_4 return to their initial position.

In this way the speaking direction is changed when the subscriber, whose station is connected for transmission, interrupts the voice signal current for a period exceeding the releasing time of the slow releasing relay. By this interruption the reversing means are operated, which means were, however, already put into condition preparatory to the reversion of the direction of transmission by a relay energized by the voice signal current, but were at the same time blocked by this relay from carrying out the reversal to its final end.

Referring now to Figure 2, the two subscriber stations S1 and S2 each have their own control means and consist substantially of the transducers LM and of the amplifiers V with the reversing switches W1 and W2 which are under the influence of relay W in such a way that they are only operated when the armature of this relay W is released. The voice controlled slow releasing relay SP controls the switch *sp*4. L designates the two-wire conductors joining the two stations. Figure 2 illustrates the working condition existing when station S1 is adjusted for transmission and station S2 for reception. The emission of the speech signals in the indicated direction causes the excitation of relay SP; switch *sp*4 is closed and relay W energized. After the emission ceases and the delay time of relay SP has expired, this relay is de-energized, and after the opening of switch *sp*4, relay W is also de-energized, whereby the switches W1 and W2 are changed over and the speaking direction is reversed. This process is repeated whenever the switch relay W is de-energized, that is any time the relay W releases its armature the reversing contacts W1 and W2 are operated. This is accomplished whenever the emission of speech signals is interrupted for a time interval exceeding the delay period of the voice controlled relay SP.

In this embodiment the position of the voice controlled relays is immaterial. They may be arranged either in the output of the amplifier (as shown) or in the line, for instance, connected to the point K of each subscriber station.

The embodiment shown in Figure 3 presents further reversing possibilities of the speaking direction as they are, for instance, described in patent application Serial No. 535,297, now U. S. Patent No. 2,460,475, granted Feb. 1, 1949. The condenser pairs *a*1, *b*1, and *a*2, *b*2 are connected to the transformer U, whose middle winding is grounded at one end and has its other end connected to the voice controlled relay SP by means of a switch *d* and the rectifier tube R. The centers of the outer windings of the transformer U are alternately connected through the reversing switches I_2 or I_6, respectively, and relay coils J and Y to sources of positive and negative potential, respectively.

The auxiliary control circuit includes four branches connected in parallel on one side to ground, and on the other side through switch II_4 and either coil I*b* of relay I or coil II*b* of relay II to the negative pole of an electrical source. The first branch comprises in series (just as in the embodiment of Figure 1) the switch I_4 operated when one of the coils I*a* or I*b* is current fed, coil II*a* of relay II*a* and coil I*a* of relay I. In this case the reversing switches I_2 and I_5 are operated at the same time as switch I_4 upon energizing of the coils I*a* or I*b* of relay I. The second and third branch comprise in series a switch *a* or *b*, respectively, operated by relays not shown, and a switch *i*4 or *y*4, respectively, operated by relays J or Y, respectively. The switches *a* and *b* remain closed on the establishment of a connection between the two subscriber stations; the switches *i*4 and *y*4 are kept in open position as long as the relays I and Y, respectively, are current fed, but are closed when these relays are

released. The fourth branch comprises in series a switch *sp*I4 operated by a slow releasing relay SPI, which is on one side connected to the negative pole of a source, and a switch *sp*4 operated by the slow releasing relay SP, which is connected to the anode of the rectifier tube R. When the relay SP is energized by the voice signal current, the switch *sp*4 connects the relay SPI to ground, whereas on releasing of relay SP the switch *sp*4 connects this fourth branch to ground. This embodiment of the invention operates as follows:

The operating condition "speaking" or "listening" of a station is determined by the position of the reversing switches I2 and I6. As illustrated in the pending application Serial No. 535,297, a change-over of the speaking direction can also be obtained by the listening subscriber. This is accomplished by operating for a short time certain switching means (not shown), whereby either relay J or relay Y is de-energized, and the switches *i*4 or *y*4, respectively, which are normally open during operation, are closed so that through the also closed switches *a* and *b*, relay coil I*b* is energized and the reversing switches I2 and I6 are switched over under the influence of relay coil I*b*, thereby changing the direction of transmission. Switch I4, which is closed at the same time, works as a holding key in order to maintain the excitation of relay I through its coil I*a* when, after a short period of interruption, relay J or Y, respectively, is again energized. By the closing of switch I4, relay coil II*a* is current fed so that as a permanent condition a circuit from ground through switch I4, relay coils II*a* and I*a*, switch II4 and relay coil II*b* to the negative potential is established. A new, short-period interruption in the circuit of the relays J or Y, respectively, again causes the closing of the switch *i*4 or switch *y*4, whereby the relay coils I*a* and II*a* are short-circuited so that relay I is released and the switches I2, I4, I6, fall back to their previous position while relay II releases its switch II4 after reopening of switch *i*4 or *y*4, respectively.

In this way the reversal of the direction of transmission of the voice signal current is carried out by the operation of switch means belonging to the subscribers.

The speaking direction may also be reversed by the voice signal current itself, through the excitation of the control relay SP, which thereby changes over its switch *sp*4; consequently, the slow releasing relay SPI is energized thereby closing the switch *sp*I4. As soon as the emission of speech signals is lacking beyond the delay period of the slow releasing relay SP, this relay SP is released and its switch *sp*4 falls back to close the circuit through switches *sp*4, *sp*I4, II4, and relay coil I*b* to the negative potential source. The switch *sp*I4 of the slow releasing relay SPI is released after a certain time interval when the current through coil I*b* has already energized relay I to reverse the switches I2 and I6 and to close the holding switch I4. Relay II is also energized and causes the reversing of switch II4. In this way the same processes are the same as in the first case in which the branch line, including switches *sp*4 and *sp*I4 takes the place of the branch including switches *a*, *y*4 or *b*, *i*4, respectively. The second change-over and thereby re-establishment of the first operating condition is obtained analogously to the change-over already described in that owing to the breaking-off of the next speech train the two relay coils I*a* and II*a* are short-circuited by the closing of the switches *sp*4 and *sp*I4.

As follows from the above, the voice controlled device according to the invention can be formed in such a way that besides the pure voice control, it allows in addition the control by means of mechanically operated means belonging to a subscriber.

Figure 4 shows the essential part of an embodiment of the invention wherein control means are arranged at each subscriber's station by means of which each subscriber may reverse the direction of transmission of the voice signal current without regard to the existing operating condition. The drawing shows the subscribers station adjusted to speaking comprising the transducer LM, the amplifier V with input transformer EU and output transformer AU, and the reversing switches II2 and II6 determining the speaking direction. The station is connected to the transmission channel *ab* and thereby to the other station by means of a transformer LU. A valve R is connected between the amplifier V and transformer LU by means of key T2. Coupled to the anode of valve R are two relays FI and FII in series and parallel to these two relays an arrangement of a metal rectifier bridge with a slow releasing relay SP. The coils of the relays FI and FII are tuned to a certain frequency and operate switches *f*I and *f*II.

The auxiliary control circuit corresponds substantially to that illustrated in Figure 1, that is it has two parallel branches, one comprising in series switch I4 operated by coils I*a* or I*b* of relay I, coil I*a* of relay I, and coil II*a* of relay II; the other branch comprising switch *sp*4 operated by the slow releasing relay SP. These two parallel branches are connected on the one hand to ground through switch *e*, which is kept closed during operation, and key T1, and on the other hand by means of switch II4 operated by coil II*a* or coil II*b* of relay II to either coil I*b* or coil II*b* and to the negative pole of an electrical source. Parallel to coil II*b* are arranged the grounded switches *f*I and *f*II. This embodiment operates as follows:

As soon as speech signals are emitted, relay SP is energized over the closed key T2 and the valve R so that switch *sp*4 is closed. Switch *e* and key T1 being closed, relay coil I*b* is energized effecting a closing of switch I4, and consequently the energizing of relay II through its coil II*a*, resulting in the reversing of switches II4, II2, and II6, as soon as switch *sp*4 interrupts the short circuit of relay coil II*a*, that is as soon as at the end of a speech train the delayed period of the slow releasing voice control relay SP has expired. All this and also the changing back to the initial positions of the several switches takes place in the same manner as is described in connection with Figure 1. The embodiment shown, however, allows each subscriber, in whatever operating condition his station may be, to establish on his own initiative, in his station the speaking and in his partner's station the listening condition. The establishment of the speaking condition in his own station can be carried out by operating the keys T1 and T2 in the sense of a short-period interruption, advantageously by a common key. With regard to the key T1, this interruption causes the release of all relays of the auxiliary circuit and, thereby, the reversing of the switches II2 and II6 from the listening position to the speaking position, while by the corresponding operation of the contact T2 the voice controlled relay SP is de-energized, so that after the short-period interruption the connection corresponds to that shown in the drawing. In order to estab-

lish the listening condition in the partner's station, the emission of a special alternating current impulse is necessary, either by transmitting a voice frequency signal amplified by the amplifier, or in another way. It is advantageous to couple the corresponding transmission means for the control impulse with the common key controlling the keys T1 and T2. This alternating current impulse flows through the coils of the relays FI and FII of the partner's station, which coils are tuned to the selected frequency. The energizing of these relays operating on the switches *f*I and *f*II, respectively, causes in the auxiliary control circuit, which is in the "speaking" condition, a closing of an additional circuit from ground through switches *f*I and *f*II and relay coil II*b* to the negative potential source, whereby relay II is excited and made to adjust the station in question to the "listening" condition.

What I claim is:

1. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal, an auxiliary control circuit for actuating said reversing means including a relay operable to put said auxiliary circuit into a condition preparatory to effecting a reversal of the direction of transmission of said voice signal current, and a slow releasing relay coupled with said channel and energized by the voice signal current to close a circuit for switching the contacts of said first mentioned relay into a position to put said auxiliary circuit into a condition preparatory to effecting a reversal of the direction of transmission, said slow releasing relay releasing a predetermined time after cessation of a speech train to complete the reversal of the direction of transmission.

2. In a telephone system with a channel for transmitting voice signal current alternately in either direction according to claim 1, means for reversing the direction of transmission of said voice signal, an auxiliary control circuit for actuating said reversing means, and a slow releasing relay coupled with said channel and energized by the voice signal current arranged at each subscriber station.

3. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal current, an auxiliary control circuit connectable to an electrical supply source for actuating said reversing means, including two relays, one of which operates said reversing means and each having two separate coils, said auxiliary control circuit having two branches connected in parallel, which branches are connectable in series to either a coil of the one or a coil of the other of said relays alternately by means of a switch operated by one of said relays, one of said parallel branches comprising in series a switch operated by the relay different from said relay operating the first mentioned switch, and the other two coils of said two relays, the other branch comprising a switch operated by a slow releasing relay which is coupled with said channel and energized by the voice signal current to put said auxiliary circuit into a condition preparatory to effecting a reversal of the direction of transmission, said slow releasing relay releasing said switch a predetermined time after cessation of a speech train to complete the reversal of the direction of transmission.

4. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal current, an auxiliary control circuit connectable to an electrical supply source including two relays, one of which operates said reversing means and each having two separate coils, said auxiliary control circuit having two branches connected in parallel which are connectable in series to either a coil of the one or a coil of the other of said relays alternately by means of a switch operated by the first mentioned relay in such a way that said switch connects said coil of the said first relay to said parallel branches when one of the coils of this first relay is energized and connects the said coil of said other, second, relay to said parallel branches when said first relay is released, one of said parallel branches comprising in series a switch closing when said second relay is energized, and the two other coils of said two relays, and the other branch comprising a switch operated by a slow releasing relay coupled by means of a rectifier device with said channel, said switch closing when said slow releasing relay is energized by the voice signal current and opening a predetermined time after cessation of a speech train.

5. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal current, an auxiliary control circuit connectable to an electrical supply source including two relays, one of which operates said reversing means and each relay having two separate coils, said auxiliary control circuit having four branches connected in parallel which are connectable in series to either a coil of the one or a coil of the other of said relays alternately by means of a switch operated by one of said relays, one of said parallel branches comprising in series a switch operated by the relay different from said relay operating the first mentioned switch and the other two coils of said two relays, the second and third of said branches each including a switch associated with one of two relays respectively, the coils of which are arranged in circuits connecting said channel with an electrical supply source, said last mentioned switches serving for manually reversing the direction of transmission, and the fourth branch including a switch associated with a slow releasing relay which is coupled with said channel and energized by the voice signal current to put said auxiliary circuit into a condition preparatory to effecting a reversal of the direction of transmission, said slow releasing relay releasing said switch a predetermined time after cessation of a speech train to complete the reversal of the direction of transmission.

6. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal current, an auxiliary control circuit connectable to an electrical supply source, including two relays, one of which operates said reversing means, each relay having two separate coils, said auxiliary control circuit having four branches connected in parallel, which branches are connectable in series to either a coil of the one or a coil of the other of said relays alternately by means of a switch operated by the relay different from said first mentioned relay operating the reversing means in such a way that said switch connects the coil of the second mentioned relay to said parallel branches when one of the coils of the second relay is energized and connects the said coil of said first mentioned relay

to said parallel branches when said second relay is released, one of said parallel branches comprising in series a switch closing when said first relay is energized and the two other coils of said two relays, the second and third of said branches each including a switch associated with one of two relays respectively arranged in circuits connecting said channel with an electrical supply source in such a way that said last mentioned switches are closed when said last mentioned relays are temporarily released, and the fourth branch comprising in series two switches, one belonging to a slow releasing relay and opening a certain time interval after said slow releasing relay is de-energized, the other switch belonging to a second slow releasing relay coupled by means of a rectifier device with said channel, said other switch connecting said first slow releasing relay to an electrical supply source when said second slow releasing relay is energized by the voice signal current and closing said fourth branch, thereby disconnecting said first slow releasing relay a predetermined time after cessation of a speech train.

7. In a telephone system, a channel for transmitting voice signal current alternately in either direction, means for reversing the direction of transmission of said voice signal current, an auxiliary control circuit connectable to an electrical supply source arranged at each subscriber station, said control circuit including two relays, one of which operates said reversing means and each having two separate coils, said auxiliary control circuit having two branches connected in parallel which are connectable in series with either a coil of the one or a coil of the other of said relays alternately by means of a switch operated by the first mentioned relay in such a way that said switch connects said coil of said first relay to said parallel branches when one of the coils of this first relay is energized and connects the said coil

of said other, second, relay to said parallel branches, when said first relay is released, one of said parallel branches comprising in series a switch closing when said second relay is energized, and the other two coils of said two relays and the other branch comprising a switch operated by a slow releasing relay coupled with said channel by means of a rectifier bridge, said last mentioned switch closing when said slow releasing relay is energized by the voice signal current and opening a predetermined time after cessation of a speech train, said parallel branches being connected to the electrical supply source and said rectifier bridge being connected to said channel through manually operable switches for reversing the direction of transmission in a subscriber station from listening to speaking by opening these switches for a short-time interval, and at least one relay with a coil tuned to a certain frequency being connected parallel to said rectifier bridge, which last mentioned relay operates a corresponding switch arranged in a circuit comprising an electrical supply source and the first mentioned coil of said first relay for reversing the direction of transmission in a subscriber station from speaking to listening by energizing said tuned relay coil with a current of the said certain frequency and thereby closing said last mentioned switch.

OTTO TSCHUMI.

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