

June 8, 1948.

L. A. KELLEY

2,442,815

RADIO CARRIER TELEPHONE SYSTEM

Filed April 26, 1944

2 Sheets-Sheet 1

Fig. 1.

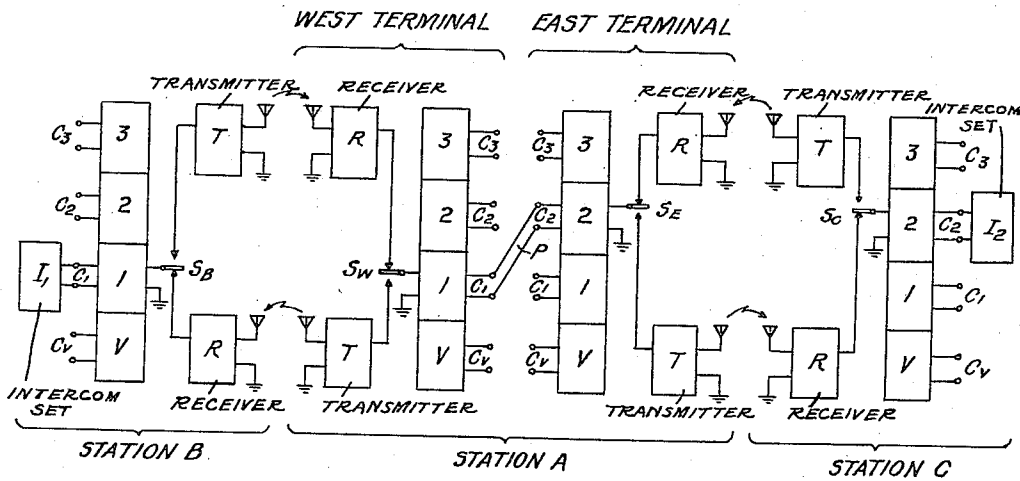
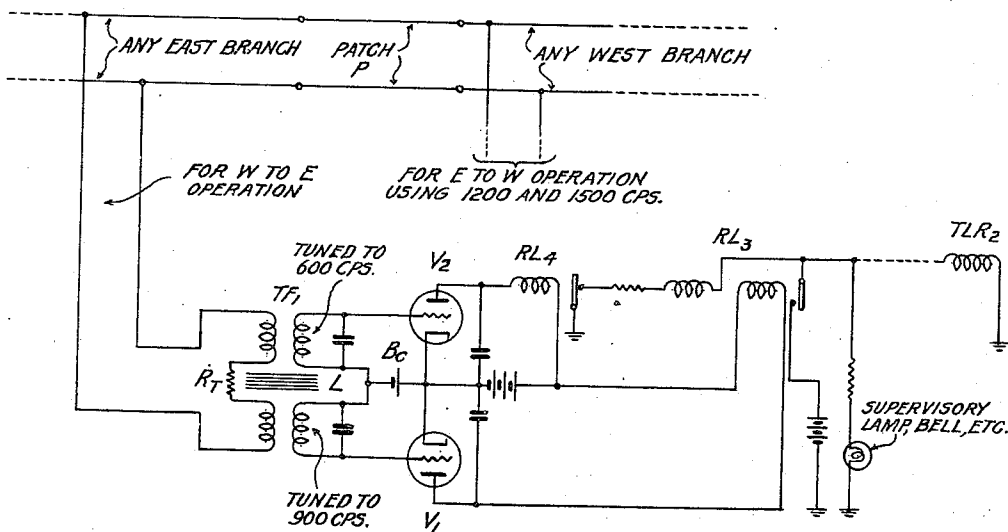


Fig. 3.



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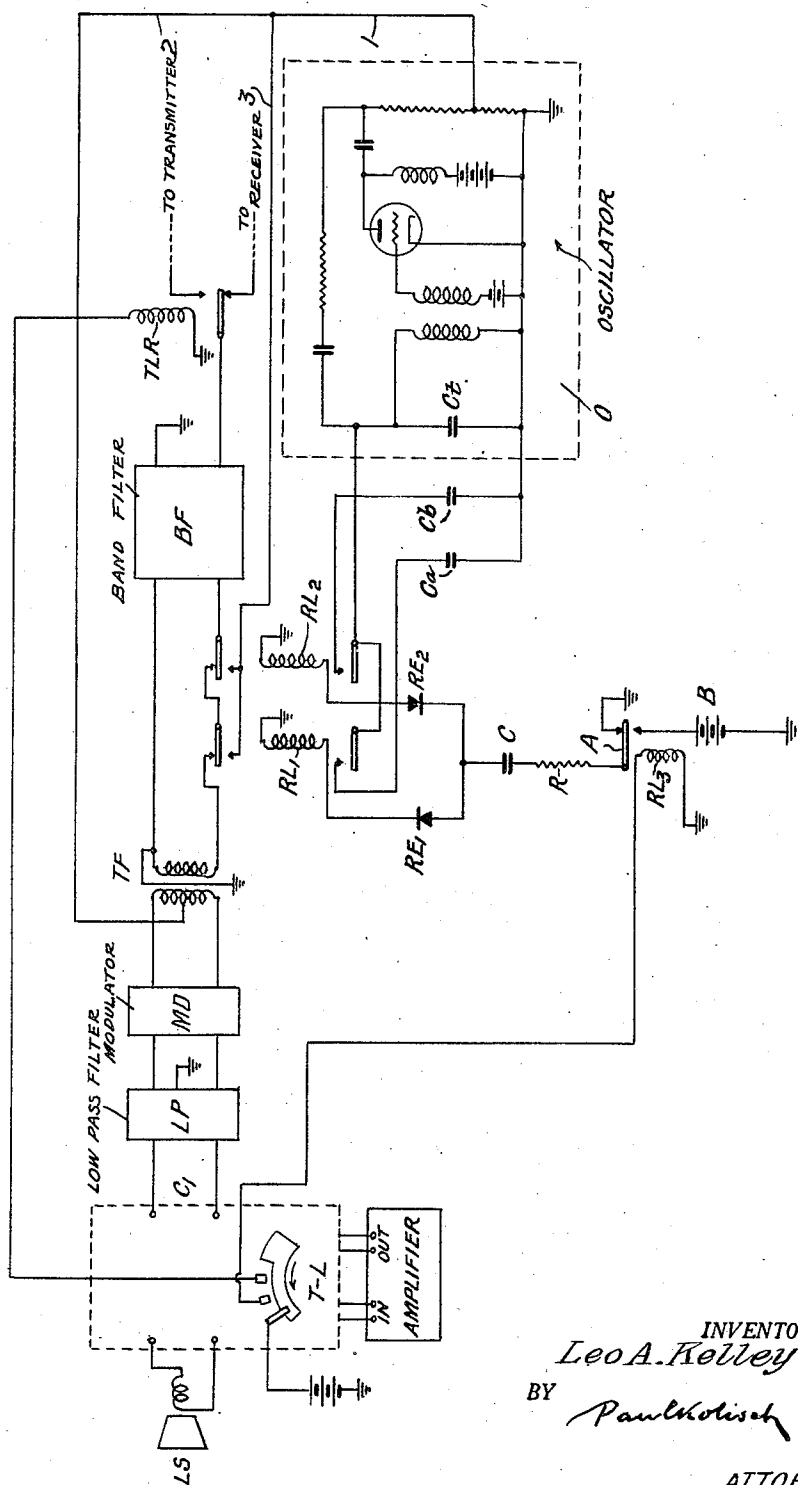
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RADIO CARRIER TELEPHONE SYSTEM

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2 Sheets-Sheet 2

Fig. 2.



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RADIO CARRIER TELEPHONE SYSTEM

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Application April 26, 1944, Serial No. 532,841

20 Claims. (Cl. 250—9)

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This invention relates to new and useful improvements in carrier radio telephone systems.

The principal object of the invention is to extend the range of operation of telephone channels in which so-called talk-listen switching is employed.

A further object is the provision of relatively inexpensive means for supervising the use of such channels without the necessity for listening to the various conversations.

In the drawings:

Fig. 1 is a block diagram;

Fig. 2 illustrates diagrammatically apparatus provided at stations B and C; and

Fig. 3, apparatus at station A, to control automatic switching of calls between stations B and C via station A.

The circuit arrangements are here described in connection with a carrier radio telephone system of the type described in my application, Serial No. 524,819, filed March 1, 1944, now U. S. Patent No. 2,417,555, where each user has a talk-listen switch which must be operated in the course of a conversation. Fig. 1 shows a block diagram of two such systems so arranged as to illustrate the utility of the present scheme in a practical communications network. Four carrier radio telephone terminals are indicated, the details of which were explained in said application. Each terminal comprises voice terminals, C_v , C_1 , C_2 , C_3 , to each of which an intercom station may be connected as, for instance, I_1 connected to terminals C_1 . I_1 does not, of course, have to be the same instrument for every conversation over the channel of which C_1 is the terminal pair. It is contemplated that not only the channel terminating in C_1 but all of the channels will be available when idle for connection to any of the intercom stations at a given carrier radio terminal. All the equipment for deriving the individual ordinary voice and carrier channels, including a relay controlled by the talk-listen switch of the intercom (TLR) and circuits, are shown by boxes labeled V, 1, 2, 3; V for ordinary voice, 1 for carrier number one, etc. In some instances, as indicated by S_b , S_w , S_e , S_c , one of the armatures of a TLR relay with its set of contacts is shown for a purpose which will be presently made clear. The radio transmitter and receiver for each carrier radio terminal are designated T and R, respectively.

Referring to Fig. 1, it is seen that "station A" comprises two carrier radio terminals, a "west terminal" and an "east terminal." The "west terminal" communicates with the terminal at

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"station B" via a radio link which may include one or more radio relay stations. Similarly, the "east terminal" communicates with the terminal at "station C" via another radio link. Intercom stations at "station A" may converse with intercom stations at "station B" via the "west terminal" or with "station C" via the "east terminal." In a network of this kind it is often desirable for an intercom at "station B" to be able to converse with an intercom at "station C" via the "west terminal" and "east terminal" at "station A." It would be possible, but in most cases it would not be satisfactory, to have a person at "station A" repeat the conversation in each direction. One of the advantages of the present arrangement is that it makes this conversation possible without the intervention or assistance of any person at "station A" during the conversation. As will be explained below, nothing more is required at "station A" than that a simple electrical connection be made prior to the conversation.

In Fig. 1, intercom I_1 at "station B" is assumed to be in conversation with intercom I_2 at "station C" via "station A." By way of illustration, I_1 is connected with carrier channel number one and I_2 with carrier channel number two, and a two-wire patching cord P is used to connect the C_1 of the "west terminal" with C_2 of the "east terminal." With the arrangements about to be described a patching cord P connected between the proper C terminals of the "west terminal" and "east terminal" at "station A" is all that is necessary to permit conversation between any intercom connected to any C terminal at "station B" and any intercom connected to any C terminal at "station C."

Assume that the person at I_1 wishes to speak. Preparatory to speaking he moves the talk-listen switch to the "talk" position. This causes the TLR relay of carrier channel number one to become energized. Consequently, S_b leaves its lower contact and touches its upper contact, and T at "station B" is put on the air. Thus, the voice currents from I_1 modulate the carrier current of carrier channel number one in carrier branch 1, the resulting lower side band modulates the radio wave in transmitter T, and the modulated radio wave is radiated. Radio receiver R at "west terminal" of "station A" receives the modulated radio wave and converts it to a facsimile of the original lower side band. All the TLR relays at "station A" remain de-energized since it is assumed that no one at "station A" is assisting in this operation and no means has yet been de-

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scribed whereby a switching operation at one carrier radio terminal will cause a switching operation at the distant carrier radio terminal with which it is working. This being so, Sw and Se are both in the deenergized position; i. e., connecting the carrier channel apparatus to the output of the associated radio receiver in each case. Therefore, the reproduced side band coming out of R of the "west terminal" can pass to the carrier apparatus of 1. A facsimile of the original voice currents comes out at C₁ and goes to carrier channel 2 of "east terminal" via patching cord P. In carrier channel 2 the reproduced voice currents modulate the carrier current appropriate to that channel and deliver the lower side band product to the armature of Se. However, Se establishes connection with the output of R of "east terminal" and the energy of the lower side band is dissipated in the output circuit of R.

It is clear that, under these circumstances, no radio wave modulated with the carrier side band will be radiated from the antenna associated with T of "east terminal" of "station A" toward "station C" and, therefore, I₂ at "station C" will not be able to reproduce the words spoken at I₁ of "station B."

The same situation exists for transmission in the opposite direction in which case the speech originates at I₂ of "station C" and the lower side band is dissipated in the output circuit of R of "west terminal" at "station A" by reason of the position of Sw.

In accordance with the present invention this inoperative condition is overcome by causing the appropriate switching operations to take place automatically at "station A." Auxiliary apparatus and connections are provided in one or more channels of the terminals local to the intercoms which, in Fig. 1, includes one or more channels at "station B" and "station C." This apparatus and these connections are shown in Fig. 2.

Furthermore, certain cooperating apparatus and connections are provided in one or more pairs of channels of the terminals where two or more simple carrier radio telephone systems terminate and it is desired to repeat automatically from a channel in one system to a channel in another system. This apparatus and these connections are applicable at "station A" of Fig. 1, for example, and they are shown in Fig. 3.

Fig. 2 is shown with particular reference to a carrier channel. The slight modification for an ordinary voice channel will be pointed out later. For the purpose of showing how the added apparatus functions with the apparatus of a carrier channel of my prior application, a significant portion of a typical carrier channel is included in Fig. 2 and as much of an intercom set as is necessary for explaining the invention. Thus, TF is a transformer corresponding to similar transformers in said application. Its left-hand winding is connected to a combined modulator and demodulator MD. The midpoint of this same winding is connected by the wires 2 and 1 to the output of carrier oscillator O within the dashed rectangle. The details shown for O are merely by way of example. Attention is principally directed to the condenser C₁ which is an important factor in determining the frequency of the current generated by the oscillator. The right-hand winding of TF is connected to the left-hand terminals of a band pass filter BF. The ungrounded side of this connection is made through the series connection of the upper armatures and their nor-

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mally closed contacts of the relays RL₁ and RL₂, as shown. The ungrounded right-hand terminal of BF is connected to the armature of the TLR relay associated with the channel for the purpose of switching the channel between the radio receiver R and the radio transmitter T. It can readily be seen, therefore, that the normal operation of the channel is not affected so long as the relays RL₁ and RL₂ remain de-energized.

The upper armatures of relays RL₁ and RL₂ also have normally open contacts which are connected in parallel and, by the wires 3 and 1, to the output of the carrier oscillator O, as shown. Relays RL₁ and RL₂ also have lower armatures which are connected in parallel and to the ungrounded side of the oscillator tuning condenser C_t. Each of the lower armatures has a normally open contact, that of RL₁ being connected to the ungrounded side of condenser C_a and that of RL₂ to the ungrounded side of C_b. The grounded sides of C_a, C_b, and C_t are, of course, all connected together.

When relay RL₁ is energized its upper armature moves to the normally open contact and thereby connects the output of the carrier oscillator directly to the ungrounded left-hand terminal of BF and opens the circuit looking back to TF and MD by reason of the armature leaving the normally closed contact. At the same time, the lower armature of RL₁ moves to its normally open contact and thereby connects condenser C_a in parallel with the oscillator tuning condenser C_t. Similarly, if relay RL₂ is energized instead of RL₁, its upper armature moves and makes the same connection and disconnection that the upper armature of RL₁ did, and its lower armature connects condenser C_b in parallel with oscillator condenser C_t.

It is well-known that when a condenser is connected in parallel with the tuning condenser of an oscillation generator, the frequency of the oscillations generated is lower than it was before the connection was made. Prior to the energizing of either RL₁ or RL₂ the carrier oscillator is generating at the normal carrier frequency for that channel and is supplying its output to the combined modulator and demodulator MD in the normal way. When RL₁ is energized, the oscillator generates at a lower frequency depending upon the capacity of C_a and supplies this lower frequency output directly to the left-hand terminals of BF. The same is true when RL₂ is energized except that the lower frequency is different if the capacity of C_b is different from that of C_a, and it is different in the present apparatus.

In order to make this more concrete, the following numerical example is offered: The capacity of C_a is of such value that it lowers the carrier frequency by the amount of 900 C. P. S., and that of C_b so that it lowers the carrier frequency by the amount of 600 C. P. S. In carrier channel number one, with a carrier frequency of 5900 C. P. S., connection of C_a causes the oscillator to generate at a frequency of 5000 C. P. S. and connection of C_b causes the oscillator to generate at a frequency of 5300 C. P. S. The band filter BF in this carrier channel transmits, with little loss in the frequency range, 3100 to 5700 C. P. S. Consequently, the currents of lowered frequencies 5000 and 5300 C. P. S. are readily transmitted through BF when the output of the oscillation generator, operating at either of these lowered frequencies, is connected directly to the left-hand terminals of BF. If, at this time, the TLR₁ relay connected with the first channel

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is energized so as to connect the right-hand terminals of BF to the radio transmitter T, a radio wave modulated by the current of frequency 5000 or 5300 C. P. S. is radiated toward the distant terminal radio receiver where a facsimile of the current of frequency 5000 or 5300 C. P. S. enters the number one carrier branch there, intermodulates in the combined modulator and demodulator with the carrier oscillator current at 5900 C. P. S. and sends on to the C₁ terminals a current of 900 or 600 C. P. S., the 900 C. P. S. being the difference between 5900 and 5000 C. P. S., and the 600 C. P. S. the difference between 5900 and 5300 C. P. S. The currents of 900 and 600 C. P. S. are utilized at the distant terminal for performing switching operations which will be described in connection with Fig. 3.

It is sufficient to state at this point that the 900 C. P. S. current will cause the appropriate TLR relay to become energized and the 600 C. P. S. current will cause that TLR relay to become de-energized. This statement may be made clearer by putting it in terms of the illustration of Fig. 1. If the apparatus of Fig. 2 is assumed to be connected with the carrier channel number one at "station B," then the 900 or 600 C. P. S. current will flow in the portion of the system at "station A" where the designations C₁, P, C₂, appear. It will be recalled that in explaining the operation in the absence of automatic switching at "station A," it was pointed out that when a person at I₁ ("station B") endeavored to talk with a person at I₂ ("station C") via the patch cord P ("station A") he could not do so because the TLR relay of carrier channel number two of the "east terminal" at "station A" remained de-energized and, as a consequence, its armature S_E remained on the contact which connects the channel with the output of the radio receiver. If this TLR relay could be energized, the armature S_E would move to the contact which connects the channel with the radio transmitter, and the person at I₁ ("station B") could talk to the person at I₂ ("station C"). A replica of the voice currents produced by I₁ ("station B") would be supplied to carrier channel number two ("east terminal") of "station A" via its C₂ terminals, the resulting lower side band current from channel two would flow via S_E (now assumed operated to the lower contact) to radio transmitter T ("east terminal") where it would modulate the radio wave, the modulated radio wave would be radiated and picked up by the antenna at radio receiver R ("station C") and demodulated in R, the resulting lower side band would pass via S_C to carrier channel number two, and finally a facsimile of the voice currents produced by I₁ ("station B") would flow via terminals C₂ to I₂ ("station C"). It may be seen then that if the TLR₂ relay of "east terminal" at "station A" is energized at the same time that the TLR₁ relay of "station B" is energized as a result of operating the switch at I₁ to the "talk" position, then the person at I₁ ("station B") can talk through to the person at I₂ ("station C"). The requirements for talking through in the opposite direction are exactly similar.

The 900 C. P. S. current which flows in the portion C₁, P, C₂ of the system at "station A" as a result of the operation of relay RL₁ associated with carrier channel number one at "station B" cause the TLR₂ relay ("east terminal" at "station A") to become energized by virtue of the circuit arrangement of Fig. 3. The arrangement of Fig. 3 also provides for the de-energization of

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the same TLR₂ relay when the 600 C. P. S. current flows in the same portion of the system. A detailed description of Fig. 3 follows after the explanation of Fig. 2 is completed.

It must be apparent now that the operation of the relays RL₁ and RL₂ should depend upon the operation of the talk-listen switch of the associated local intercom station. Operation of the RL₁ relay causes the energizing of a particular TLR relay at a remote station associated with a different terminal-to-terminal carrier radio telephone system, while operation of the companion RL₂ relay causes the de-energization of the same TLR relay. In the present arrangement, the RL₁ relay is energized momentarily when the talk-listen switch is first moved to the "talk" position and the RL₂ relay is energized momentarily near the first part of the movement of the talk-listen switch as it returns to the "listen" position. As a practical matter, "momentarily" means less than a few tenths of a second.

In Fig. 2, one simple way in which the momentary operation of relays RL₁ and RL₂ may be secured, is shown. The winding of relay RL₃ is connected in an energizing circuit controlled by one of the stationary and movable contacts on the talk-listen switch T-L, similar to the arrangement described in said application for energizing the TLR relay. When the relay RL₃ is energized by moving the talk-listen switch toward the "talk" position, its armature A moves to its lower contact completing a circuit including, in series, the source of unidirectional voltage B, resistance R, condenser C, and the two branches in parallel comprising in one branch the rectifier RE₁ and the winding of relay RL₁, and in the other branch the rectifier RE₂ and the winding of relay RL₂, and return paths via ground to the other side of B. The rectifiers RE₁ and RE₂ are conductive in one direction only. In Fig. 2, they are oppositely poled with respect to the source B. As soon as armature A touches the lower contact, a momentary unidirectional current flows, charging condenser C. Rectifier RE₁ is so poled as to be conductive to this current so that relay RL₁ is momentarily energized. At this time relay RL₂ is not energized because rectifier RE₂ is so poled as not to be conductive to this current. However, when the talk-listen switch is released to the "listen" position, condenser C discharges via armature A to ground. The discharge is also momentary and opposite in direction to the charging current. Therefore, rectifier RE₂ is conducting to the exclusion of RE₁, and relay RL₂ is momentarily energized. The factors controlling the magnitude, shape and duration of these current pulses are well-known and hence will not be further discussed. Other simple or more elaborate circuits may be employed for this purpose in place of the one shown in Fig. 2.

In order to insure that the operation of RL₂ will take place while the armature of the TLR relay still connects the carrier channel to the radio transmitter T—so that the signal created by the operation of RL₂ will be radiated—the points in the travel of the talk-listen switch where relays TLR and RL₃ are energized should be displaced by an ample margin. That is, relay TLR should be energized near the first part of the movement of the switch from "listen" to "talk" and relay RL₃ near the end of this movement. To the same end, the TLR relay may be made to have a quick make and slow release.

Fig. 3 consists of two similar shunt circuits, one of which is shown in detail. These circuits

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are connected in shunt to the C terminals at a station, such as "station A" of Fig. 1, where the voice terminals of more than one carrier radio telephone system are located and it is desired to repeat automatically from one system to another system by means of a patching cord such as P. In Fig. 3 the circuit shown in detail is connected in shunt to the C terminals of an east branch and such circuit is responsive to signals emanating from a channel associated with the remote terminal in the system toward the west. It should be noted that Fig. 2 may be applied to any or all of channels 1, 2 and 3 at "station B," and that the switching signals flowing to corresponding terminals C₁, C₂ and C₃ of the "west terminal" at "station A" will, in each case, consist of a spurt of current of either 900 or 600 C. P. S. Consequently, when any one of the C terminals of "west terminal" is patched to any C terminal of "east terminal," the latter is supplied with a spurt of 900 C. P. S. current just prior to talking west to east, and a spurt of 600 C. P. S. current just after the talking in this direction ceases. The detailed shunt circuit is, therefore, typical of the apparatus associated with each channel of the "east terminal." The uncompleted shunt circuit in Fig. 3 connected across the C terminals of a west branch is intended to provide similar switching operations when talking in the east to west direction; i. e., from "station C" via any channel to the "east terminal" at "station A," thence via a patching cord to any channel of the "west terminal" at "station A" to "station B." Except for details relating to the frequency of the signal pulses, the two shunt circuits are the same, so a detailed explanation of the shunt circuit connected across the C terminals of an east branch will be given as typical for both shunt circuits.

Referring to Fig. 3, the shunt circuit for west to east operation starts at the place where it is connected across the C terminals of an east branch. It goes first to a transformer TF₁ comprising two primary and two secondary windings. The rectangular symbol marked L indicates a magnetic shunt or high flux leakage path between the two sets of primary and secondary windings, the sets being taken in the sense that the upper primary and upper secondary windings constitute one set, and the lower primary and lower secondary the other set. The transformer may consist in fact of two transformers, one for each set, or a single unit may be constructed using shell-type laminations and putting one set of windings on one outside leg, the other set of windings on the other outside leg, leaving the central leg unwound. In the latter case, the central leg would constitute the magnetic shunt indicated by L in Fig. 3. The advantage of thus magnetically separating the windings will become clear as the description proceeds. In practice, the primary windings may be alike and, likewise, the secondary windings; in other words, effectively two identical transformers.

Each secondary winding is tuned to a particular frequency by means of a shunt connected condenser, the lower secondary being tuned to a frequency of 900 C. P. S., and the upper to a frequency of 600 C. P. S. The magnetic shunt assists greatly in making the tuning of the secondaries independent of each other. This is further aided by the connection of a high resistance R_r in series with the primary circuit. The resistance value of R_r is made high with respect to the reactance of each primary winding which,

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as noted, may be the same in practice, at the signal frequencies, in this case 900 and 600 C. P. S. This improves the sharpness of tuning in the respective secondary circuits. Usually the resistance value of R_r, thus determined, will be much larger than the impedance level over the voice frequency range in the branch circuit (see Fig. 3, "any east branch") before the shunt circuit is connected. In case it is not, it should be made so in order to reduce the shunting effect of the added circuit to a negligible magnitude.

The secondary windings are each connected between the control grid and cathode of a triode. They are given many more turns than the associated primary windings in order to secure a substantial voltage set-up. The lower secondary winding tuned to 900 C. P. S. is connected between the input electrodes of tube V₁, while the upper secondary winding tuned to 600 C. P. S. is similarly connected with tube V₂. A negative grid bias is applied between the control grids and cathodes of these tubes, as shown by the battery B_c, sufficient to cause plate current cut-off in both tubes when no signal is being received. It is evident that a current of 900 C. P. S., picked up by the shunt circuit, will excite only the lower secondary which is tuned to 900 C. P. S., and when this happens a current will flow in the plate circuit of V₁ only. Similarly, a current of 600 C. P. S. will cause a current to flow in the plate circuit of V₂ only. In the plate circuit of each tube, a by-pass condenser is connected so that substantially only direct current flows for the duration of the 900 or 600 C. P. S. signal, as the case may be.

The direct current component of the plate current of V₁ is made to flow through the right-hand winding of relay RL₃. Recalling that operation of the talk-listen switch to the "talk" position at "station B" causes a spurt of 900 C. P. S. current to flow in the circuits joined by the patching cord (at "station A") and, therefore, in the shunt circuit now under consideration, it is clear that this operation of the talk-listen switch causes a pulse of direct current to flow through the right-hand winding of relay RL₃, energizing it momentarily. When this happens the armature of RL₃ moves against its normally open contact and thereby completes a number of circuits, each including the voltage source connected between ground and the armature contact, as shown in Fig. 3. One of these completed circuits comprises, in series, the voltage source, the left-hand winding of RL₃, a resistance for controlling the current in this circuit, and the armature and its normally closed contact of another relay RL₄, the circuit being completed via ground. This is a locking circuit for RL₃ because, once this circuit is closed by the pulse of current through its right-hand winding, the relay is maintained energized by current flow through the left-hand winding in this circuit until it is later broken by the energizing of relay RL₄. In addition to closing the locking circuit, the voltage source is also connected to energize relay TLR₂ of the east branch to which this shunt circuit is connected. The voltage source is also connected by the operation of RL₃ so as to light a supervisory lamp or the like, indicating to an attendant that the circuit is in use for talking in the west to east direction.

At the end of the talking period, the talk-listen switch at "station B" is released. At this time, as already explained, a spurt of 600 C. P. S. current is caused to flow in the circuits joined by

the patching cord (at "station A") and hence in the shunt circuit of Fig. 3. This causes a pulse of current in the plate circuit of V_2 , the direct component of which flows through the winding of relay RL_4 , energizing it momentarily. This causes the armature of RL_4 to leave its contact briefly, but in so doing it opens the holding circuit of the left-hand winding of RL_3 which becomes and remains de-energized until the receipt of the next 900 C. P. S. current spurt. When the relay RL_3 becomes de-energized, its armature moves away from the contact to which the voltage supply is connected, and thus de-energizes all the circuits to which the armature is connected. Of these, the holding winding circuit has been noted. In addition, the TLR relay is de-energized and the supervisory lamp goes out.

The net result of the operations described in the preceding two paragraphs is, to use the illustration of Fig. 1, that the person at I_1 ("station B") is able by the manipulation of his talk-listen switch to control not only the TLR relay represented by S_B at "station B" but also the TLR relay represented by S_A at the "east terminal" of "station A." When he moves his switch to the "talk" position, both S_B and S_A move, appropriately for talking to I_2 at "station C," to connect the associated carrier channels with their respective radio transmitters and, when he releases his switch to the "listen" position both S_B and S_A move, appropriately for listening to I_2 at "station C," back to the positions shown in Fig. 1, where they connect the associated carrier channels with their respective radio receivers. It is obvious that this is typical of the control which can be effected at "station B" over any carrier channel equipped with the apparatus of Fig. 2 upon any channel of the carrier radio telephone system comprising the "east terminal" at "station A" and the terminal at "station C" which is equipped with the apparatus of Fig. 3 at the "east terminal."

Similar control can be exercised on any carrier channel at "station C" by equipping such channel with the apparatus of Fig. 2. In this case, however, it is necessary to use currents of different frequencies from those employed for west to east control. Referring to Fig. 2, for example, the capacity of C_a is now of such value as to lower the normal carrier frequency by 1500 C. P. S. and the capacity of C_b to lower the normal carrier frequency by 1200 C. P. S. Consequently, when the person at I_2 ("station C") moves his switch to the "talk" position, a spurt of 1500 C. P. S. current flows via the terminal C_1 at the "west terminal" at "station A," and when he releases his switch to the "listen" position, a spurt of 1200 C. P. S. current flows. Referring to Fig. 3, the uncompleted shunt circuit connected across the branch designated "any west branch" is responsive to these 1500 and 1200 C. P. S. switching signals. The details of this shunt circuit are precisely the same as for the shunt circuit shown for the 900 and 600 C. P. S. switching signals with the exception that the transformer secondaries are tuned for 1500 and 1200 C. P. S. instead of 900 and 600 C. P. S., respectively, and, of course, the associated TLR relay of a west branch instead of an east branch is energized upon the operation of the corresponding relay to RL_3 . Therefore, the person at I_2 ("station C") can control the east to west talking circuit by controlling the TLR relay at "station C" represented by S_C and the TLR relay at "west terminal" of "station A" represented by S_W .

Thus, the persons at I_1 ("station B") and I_2 ("station C") can converse with each other by joining their channels with a patching cord P and without the further assistance of any person at "station A." The switching signals being momentary do not interfere with the use of the circuit for conversation. Furthermore, an attendant at "station A" by observing the supervisory lamps for a particular patching connection will know when to remove the patching cord and free the channels for the use of others, not only for conversations between "station B" and "station C" but also from "station A" to either "station B" or "station C."

It was mentioned earlier that the circuit of Fig. 2 should be slightly modified for the ordinary voice channel. The reason for this is that an oscillator is required to generate the switching signal currents. In each of the carrier channels an oscillator is ready at hand in the form of the carrier oscillator. The arrangement of Fig. 2 makes use of the carrier oscillator but, as no carrier oscillator is used in the ordinary voice channel, it is necessary to supply one. Therefore, a separate oscillator is supplied in the ordinary voice channel for oscillator O of Fig. 2. Wire 2 is omitted for obvious reasons. Condenser C_t tunes the oscillator to a frequency of 900 C. P. S. Condenser C_a and the lower armature of relay RL_1 are omitted. Condenser C_b has a value of capacity which lowers the frequency of the oscillator to 600 C. P. S. when relay RL_2 is energized. In all other respects Fig. 2 is the same as for any carrier channel. The signal frequencies of 900 and 600 C. P. S. apply, of course, to "station B." At "station C" these frequencies are 1500 and 1200 C. P. S., respectively.

As to Fig. 3, the arrangement is precisely the same for the ordinary voice channels as it is for each carrier channel.

Many variations and extensions of the arrangements here described will occur to those skilled in this art. For instance, "station A" may be the focal point for more than the two carrier radio telephone systems shown in Fig. 1. Communication may be had from one outlying station to any other outlying station via "station A" employing circuit arrangements of the character described. Also, the shunt circuits of Fig. 3 may be associated with the cord circuits rather than the individual branch circuits, in which case provision should be made for connecting in the winding of the proper TLR relay when plugging in. Tubes V_1 and V_2 of Fig. 3 may be of other than the triode type with appropriate circuit alterations. The arrangement of Fig. 3 may be combined with that of Fig. 2 at a single station for controlling the switching operations at still another station. The particular variation used in any case will usually depend upon the number and location of the points to be interconnected and the character of the telephone service desired.

The word "channel" as used in this specification is meant to designate means for establishing and reserving in the ether or on a physical line a predetermined portion of a transmission frequency spectrum for the transmission of electrical signals.

What I claim is:

1. In a carrier radio telephone system, two terminal stations, each having a radio transmitter and receiver, a plurality of two-way channels at each station, a set consisting of a telephone

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and a two-position switch, means for connecting the set with a channel of the first station, means responsive to the movement of the switch into one position for connecting the first and the second station with their associated transmitters, and means responsive to the movement of the switch into the second position for connecting said stations with their associated receivers.

2. The system according to claim 1, and a relay at the first station having a circuit controlled by said switch, means at the first station for sending distinctive signals to the second station in the two positions of the switch, and a relay at the second station responsive to said signals.

3. The system according to claim 1, a relay at each station for alternately connecting the station with the associated transmitter and receiver, a circuit for the relay at the first station controlled by the switch, means for sending distinctive signals in each position of the switch, and a circuit for the relay at the second station responsive to said distinctive signals.

4. In a carrier radio telephone system, two terminal stations, each having a radio transmitter and a receiver, a plurality of two-way channels at each station, a set consisting of a telephone and a two-position switch adapted to connect the telephone with a channel at the first station for talking and listening, means operative in the talking position of the switch for connecting the first station to the associated transmitter and for transmitting a first signal, means operative in the listening position of the switch for connecting the first station with the associated receiver, and for transmitting a second signal, and means at the second station responsive to the first signal for connecting it with the associated transmitter and responsive to the second signal for connecting it with the associated receiver.

5. In the system according to claim 4, a relay at each station for alternately connecting the station with the associated transmitter and receiver, means at the first station operable when the switch is moved into the talking position for first energizing the associated relay and then producing a first signal, means at the first station operable when the switch is moved into the listening position for producing a second signal while the transmitter is connected with the station and then connecting the station with the associated receiver, and a circuit for the relay at the second station responsive to the first signal to connect the station with the associated transmitter and to the second signal to connect it with the receiver.

6. In a carrier radio telephone system, four terminal stations, each having a radio transmitter and receiver, a plurality of two-way channels at each station, a telephone for each channel at the first and second stations, means for establishing two-way communication between channels at the first and second stations over channels at the third and fourth station, including a two-position switch for each telephone connecting in one position the associated channel with the telephone for talking and in the second position for listening, a first means for each channel for connecting the associated channel alternately to the receiver and the transmitter at the terminal station, a second means for certain channels, means operative in the talking position of the switch for operating the first and second means of the associated channel, means for connecting a channel of the third station with a

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channel of the fourth station, and means controlled by a second means for operating the first means of the last-mentioned channel.

7. The system according to claim 6, and in which the first means is a relay whose circuit is closed in the talking and opened in the listening position of the switch, and contacts for the relay for connecting the telephone of the associated channel with the transmitter of the associated station in the talking position, and with the receiver in the listening position of the switch.

8. The system according to claim 6, and in which the second means is a relay whose circuit is closed in the talking and opened in the listening position of the associated switch.

9. The system according to claim 6, and in which the first means comprises a relay connecting over a back contact with the associated receiver and over the front contact with the associated transmitter, and means operative in the talking position of the switch for energizing the relays at the first and fourth stations.

10. The system according to claim 6, and means controlled by the switch for successively operating the first and second means of the associated channel when it is moved into the talking position.

11. The system according to claim 6, and in which the first and second means are relays, and the second relay is energized when the switch is moved into the talking and de-energized when it is moved into the listening position, means for energizing the first relay of the connected channel of the fourth station in response to the energization and means for de-energizing it upon the de-energization of said second relay.

12. The system according to claim 6 and in which the last-mentioned means comprises means for sending a signal of a predetermined frequency to operate the first means associated with the connected channel of the fourth station to connect with the associated transmitter.

13. The system according to claim 6, and in which the last-mentioned means comprises means for sending a signal of a predetermined frequency to operate the first means associated with the connected channel of the fourth station to connect with the associated receiver.

14. The system according to claim 6, and in which the last-mentioned means comprises means for transmitting a signal of a predetermined first frequency when the switch is moved into the talking position and a signal of a predetermined second frequency when the switch is moved into the listening position, and means responsive to said first frequency for operating the first means of the connected channel of the fourth station to connect the channel with the associated transmitter and means responsive to the second frequency for operating the last-mentioned first means to connect the channel with the associated receiver.

15. In a multiplex radio communication system, two terminal stations, each comprising a radio transmitter and receiver, a plurality of carrier channels at each station, each carrier channel containing an oscillator and a modulator, the oscillator of each channel being arranged to generate a carrier of different frequency, a relay at each station for controlling the alternate connection of a given channel at each station to the associated transmitter and the receiver, a telephone, a switch for connecting the telephone with a channel at the first station for talking and listening purposes, a circuit for the relay

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at the first station controlled when the switch is moved towards the talking position, means controlled by the switch for operating said oscillator to produce a distinctive signal, and a circuit for the relay at the second station responsive to said signal.

16. The system according to claim 15, and in which said oscillator comprises tuning means, means responsive to the moving of the switch to the talking position for momentarily varying the tuning of the oscillator of the connected channel to a predetermined extent, means responsive to the moving of the switch to the listening position for momentarily varying the oscillator of the connected channel to a different extent.

17. The system according to claim 15, and in which the switch when moved to the talking position momentarily varies the tuning of the oscillator of the channel with which the telephone is connected to a predetermined extent, and when moved to the listening position momentarily varies the tuning to a different extent, two tuned circuits at the second station responsive, respectively, to signals produced by the momentary variations in the tuning of the oscillator, and means controlled by said tuned circuits for controlling the circuit of the relay at the second station.

18. The system according to claim 15, and in which the switch when moved to the talking position momentarily varies the tuning of the oscillator of the channel with which the telephone is connected to a predetermined extent, and when moved to the listening position momentarily varies the tuning to a different extent, two tuned circuits at the second station responsive, respectively, to signals produced by the momentary variations in the tuning of the oscillator, a second and a third relay at the second station, an energizing circuit closed for the second relay by the tuned circuit responsive to the movement of the switch into the talking position, and an energizing circuit closed for the third relay by the other tuned circuit, a locking circuit for the second relay controlled in a back contact of the third relay, the circuit of the first relay at the second station being controlled in a front contact of the second relay.

19. In a multiplex radio communication system, two terminal stations, each comprising a radio transmitter and receiver, a plurality of carrier channels at each station, each carrier channel containing an oscillator and a modulator,

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the oscillator of each channel being arranged to generate a carrier of different frequency, a first relay at each station, multiple connections from the channels at each station to the associated transmitter and the receiver controlled by the associated relay, a telephone, a two-position switch for connecting the telephone with a channel at the first station, in one position for talking and in the second position for listening, a circuit for the relay at the first station closed when the switch is moved towards the talking position, a second relay at the first station, a circuit for the second relay closed by said switch when moved towards the talking position after the energization of the first relay, means controlled by the second relay for operating the oscillator of the channel with which the telephone is connected to produce a distinctive signal, and a circuit for the first relay at the second station responsive to said signal.

20. The system according to claim 19, and in which said oscillator comprises a tuning condenser, a first signaling relay, means controlled thereby for connecting a condenser of a predetermined value in parallel with the tuning condenser, a second signaling relay, means controlled thereby for connecting a condenser of a different predetermined value in parallel with the tuning condenser, said signaling relays having parallel circuits, oppositely poled rectifiers in the individual branches of said parallel circuits, a condenser and a resistance in a common branch of the parallel circuits, an armature controlled by the second relay in the common branch of said circuits for alternately connecting it to ground and battery, the elements of said parallel circuits being so proportioned that in one position of the armature one signaling relay and in the second position the second signaling relay is momentarily energized.

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