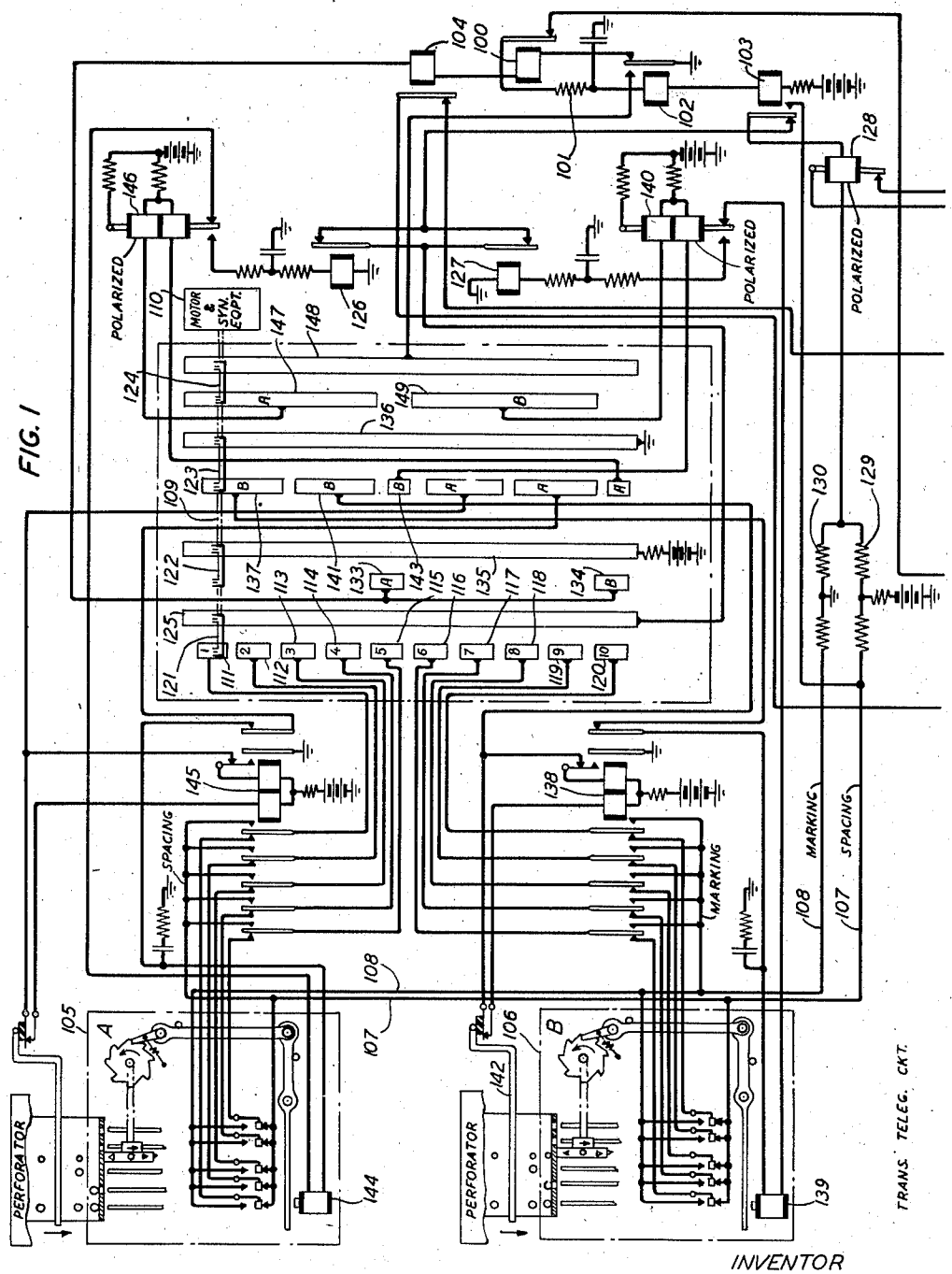
Sept. 22, 1942. A. E. MELHOSE 2,296,362

SIGNALING SYSTEM

Filed Aug. 31, 1940 4 Sheets-Sheet 1

FIG. 1



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SIGNALING SYSTEM

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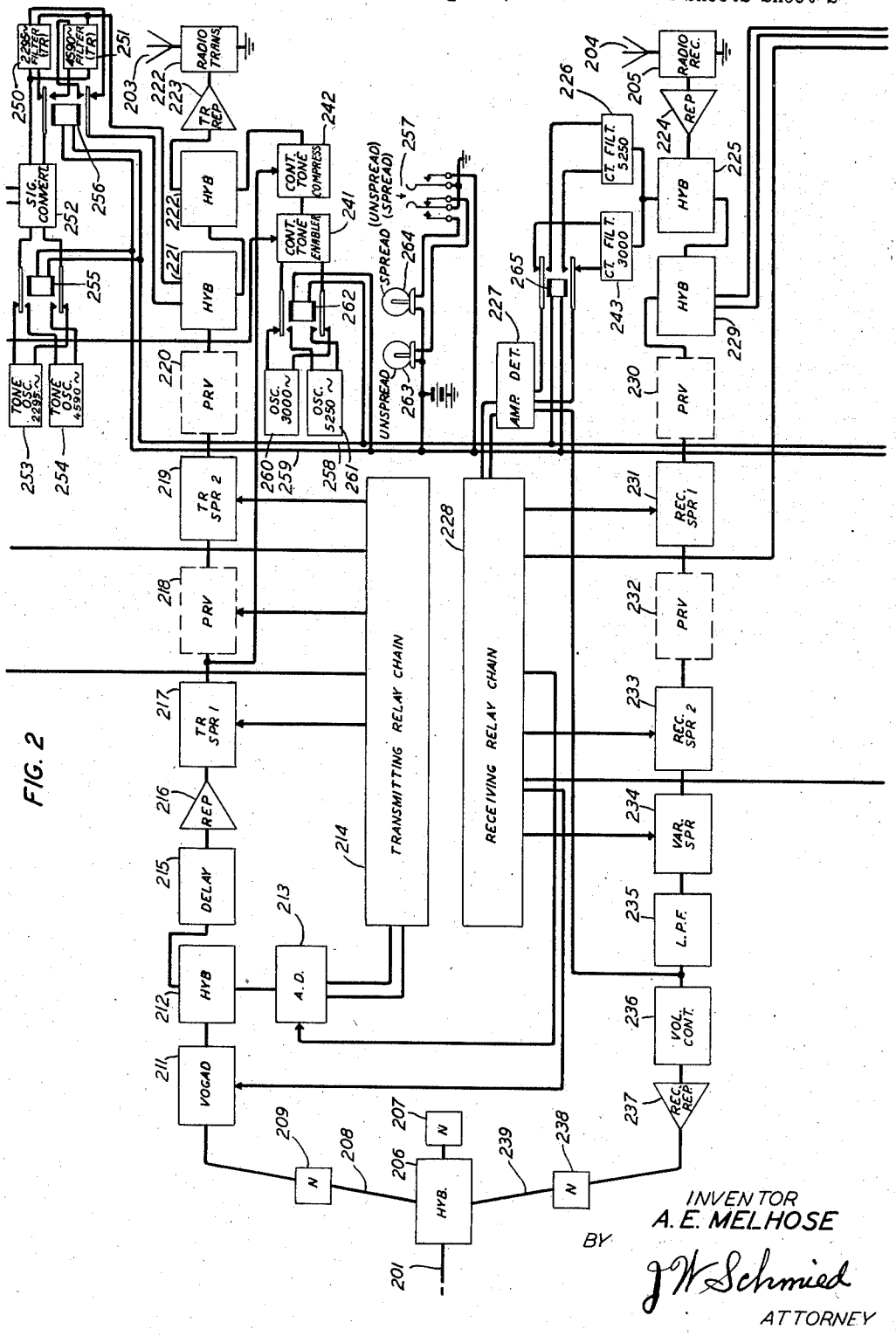

FIG. 2

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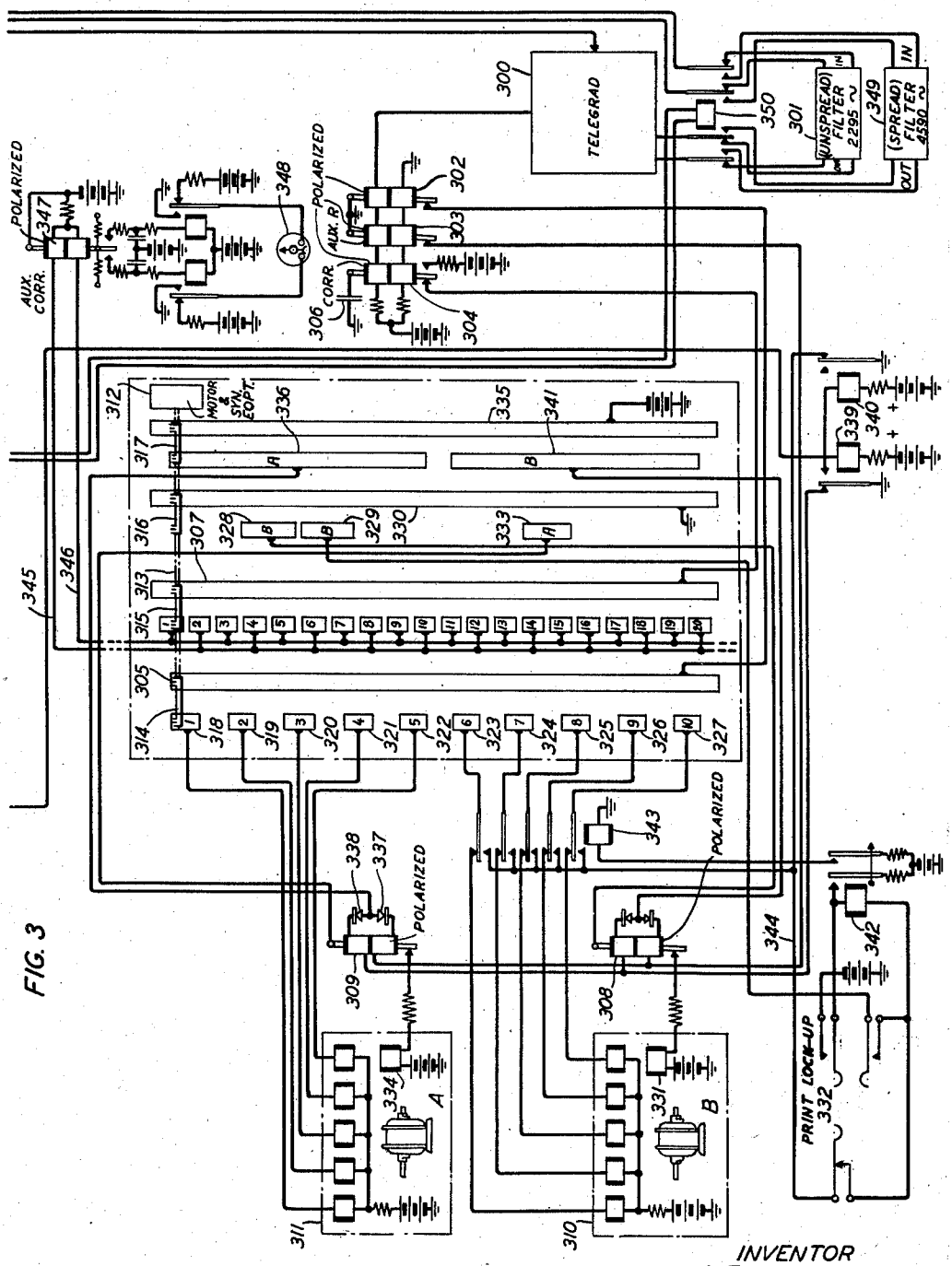

FIG. 3

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SIGNALING SYSTEM

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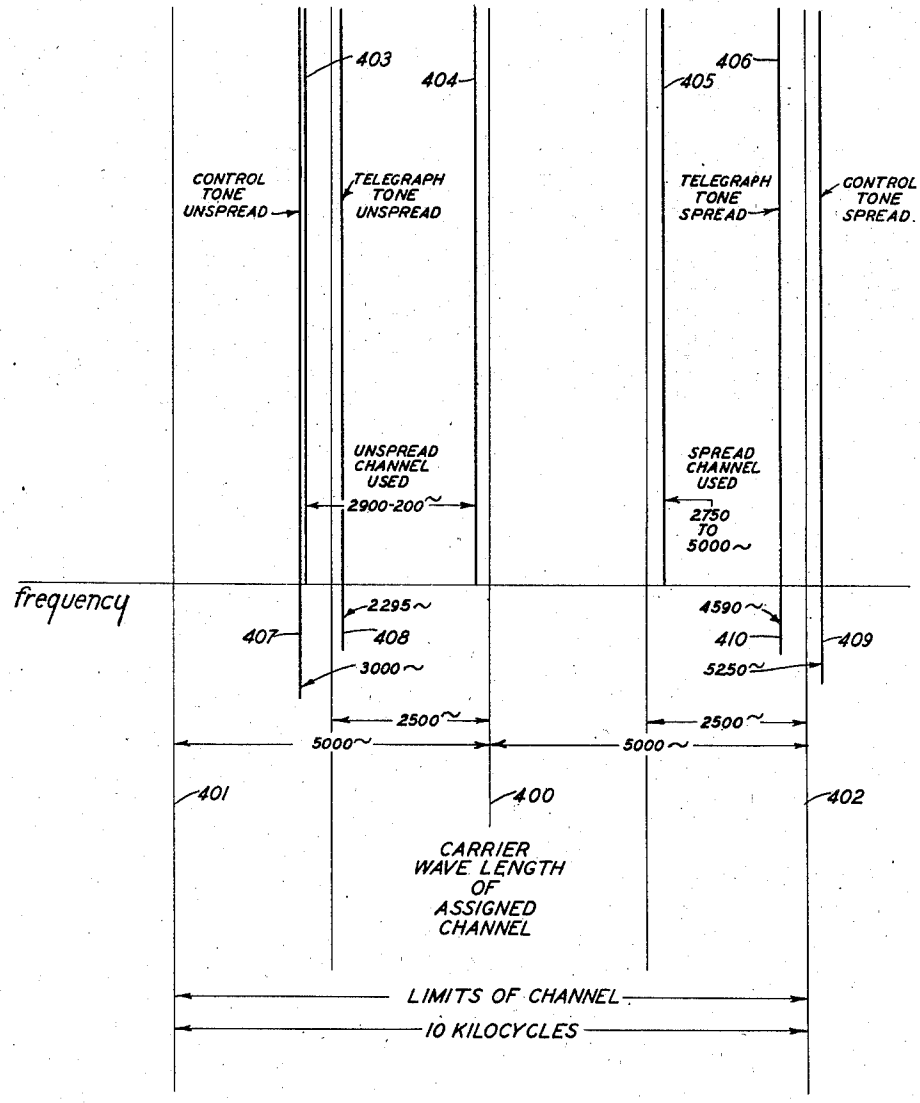
FIG. 4



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Patented Sept. 22, 1942

2,296,362

UNITED STATES PATENT OFFICE

2,296,362

SIGNALING SYSTEM

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Application August 31, 1940, Serial No. 354,987

9 Claims. (Cl. 179—4)

This invention relates to communication systems and particularly to systems where a first type of transmission is interpolated in a second type of transmission during lulls and pauses in such second type of transmission.

The object of the invention is to provide flexibility in the form of adjusting means to meet varying service conditions. In a preferred specific embodiment of the invention an interpolated telephone and telegraph system is shown wherein telegraph signals are interpolated in telephone conversations during lulls and pauses in such conversation. The transmission is by way of carrier current, it being immaterial whether the link is a radio channel or otherwise, though it is here shown as the former.

In carrier current transmission a space of some 10 kilocycles is generally allowed, this being about 5 kilocycles on each side of the carrier frequency. It has been found that this 10 kilocycle band may be divided in four parts and that it is feasible to use these four parts as four communication channels. There are thus two channels on each side of the carrier, each aproximately 2.5 kilocycles wide, one close to the carrier and the other 2.5 kilocycles distant. The channel next the carrier provides a band of speech frequencies of from 200 cycles to about 2750 cycles while the distant channel provides a band of from 2750 to 5000 cycles. To transmit over the outside or distant band requires an additional modulation which is well known and fully explained in Patent No. 1,502,889 to Van der Bijl.

In the system herein disclosed it is proposed to employ two of these four possible channels, one close to and on one side of the carrier, the other distant from and on the other side of the carrier. For the purpose of telegraph transmission and switching control, certain alternating currents of frequencies within or near the band of speech frequencies are employed. Thus a control tone which is transmitted with speech for switching purposes is just outside the band of speech frequencies so that it may be filtered out after it has performed its proper function. In addition, a telegraph tone which is transmitted at times occurring in lulls and pauses in speech and over circuits peculiarly adapted to the transmission of speech is within the band of speech frequencies. These may be spoken of as the fixed signaling currents.

When the speech band on one side of and close to the carrier is being used, the control tone may be of 3000 cycles and the telegraph tone may be of 2295 cycles, but when the other channel is being used these figures must be changed, the control tone to 5250 cycles and the telegraph tone to 4590 cycles so that there will be no interference with the twin channel which might be in use for some other purpose. By the same token the circuits affected by these tones must be changed.

A feature of the invention, therefore, is adjustable means at each terminal of the system for simultaneously changing thereat the frequencies of the fixed signaling currents and the frequency characteristics of the circuits affected thereby.

This invention is an improvement in the system disclosed in Patent 2,207,720 granted to Cole et al. July 16, 1940.

The drawings consist of four sheets of diagrams. With Figs. 1, 2 and 3 placed together a circuit diagram of one terminal of an interpolated telephone and telegraph system is shown.

Fig. 1 shows the transmitting telegraph circuits;

Fig. 2, partly schematic and partly circuit diagram, shows the telephone and controlling circuits;

Fig. 3 shows the receiving telegraph circuits;

Fig. 4 is a diagram illustrating how the assigned channel with its carrier wave and both side-bands may be utilized for twin channel purposes.

In order to clearly understand the present invention the diagram of Fig. 4 will first be explained. A centrally located vertical line **400** indicates the carrier frequency of an assigned channel. Usually these channels are about 10 kilocycles wide with a side-band of 5 kilocycles extending to each side. The vertical line **401**, therefore, indicates the limit in one direction and the vertical line **402** indicates the limit in the other direction. For practical purposes intelligible speech may be included in the band of about 2500 cycles, that is one-quarter of the width of this assigned channel. Theoretically, it is possible, therefore, to divide this 10-kilocycle band into four parts and to use these four parts for four separate speech channels. Practically, there are some difficulties involving cross-talk and other interference phenomenon which at present prevent the full use of the channel in this manner. However, it is entirely practical at the present time to use one chanel near to and on one side of the carrier wave for a speech channel and another channel distant from and on the other side of the carrier wave for a speech channel. The vertical lines **403** and **404** define the speech channel on one side of and near to the carrier wave and the vertical lines **405** and **406** define the

other channel distant from and on the other side of the carrier wave.

In the interpolated telephone and telegraph system it is necessary to send certain alternating current waves for control purposes. During the sending of speech a control tone which is just outside the speech band is sent with speech and during the times that speech is not present a telegraph tone within the speech band is transmitted. The vertical line 407 represents a control tone and the vertical line 408 represents a telegraph tone.

When the other of the twin channels is used it is necessary to shift the frequencies of these control tones and hence the tone represented by the line 407 is shifted to the tone represented by the line 409 and the telegraph tone represented by the line 408 is shifted to the frequency represented by the line 410.

It will be understood that the various frequency designations on this diagram are purely by way of example and that other figures may with equal facility be employed. It will further be understood that if the line 409, which is slightly outside the assigned channel, is objectionable, then the same pattern may be used but a carrier wave shifted slightly toward the left may be employed so that the entire diagram will be within the assigned channel.

The term "spread" and "unspread" are employed by workers in this art to designate the two channels thus created. The unspread channel is that channel which is near to and on one side of the carrier frequency and the spread channel is that channel which is distant from and on the other side of the carrier frequency. The spread channel requires an additional modulation but since this means is well known in the art it will not further be explained at the present time.

Referring to the details of the speech control circuits, one terminal of a system is shown, but it will be understood that at some distant point a similar terminal is located, so that speech coming in over channel 201 will be transmitted from the radio transmitter 202 and its antenna 203, to be received at the said distant point over the antenna 204 and the radio receiver 205 for transmission into the speech path at that point corresponding to the channel 201.

While speech is being transmitted from channel 201 over the antenna 203 the telegraph transmitting apparatus of Fig. 1 is inactive and the telegraph receiving apparatus of Fig. 3 at the distant point is similarly inactive. By the same token, the telegraph transmitting apparatus of Fig. 1 at the distant point and the telegraph receiving apparatus of Fig. 3 at the near end, as shown, will be in operation.

In general, speech over channel 201 enters the hybrid coil 206 provided with the usual balancing network 207 passes over path 208 through the network 209 to the voice operated gain adjusting device (termed vogad, for short) 211. From the vogad 211 speech currents enter the hybrid coil 212 where they split, part going on to the main speech channel and part entering the syllabic amplifier-detector 213 for control purposes. The output of the amplifier-detector 213 feeds into the transmitting chain 214 which performs a variety of switching functions, as will be more clearly set forth hereinafter. At present it is sufficient to say that the transmitting chain 214 clears the way for the speech currents to the antenna 203 and that the distant receiving terminal similarly conditions the receiving circuits thereat for the proper reception of the speech currents. The main portion of the speech currents then passes from the hybrid coil 212 into the delay circuit 215 through a repeater 216 and the first transmitting suppressor 217. Thereafter the speech path is through privacy circuit 218, the second transmitting suppressor circuit 219 and another part of the privacy circuit 220 to the hybrid coil 221. The speech currents then pass to the hybrid coil 222, thence to the transmitting repeater 223 and to the radio transmitter 202.

At the distant receiving end the speech currents transmitted from the radio receiver pass through the receiving repeater 224 into the hybrid coil 225. At this point the control tone which accompanies speech is diverted to the control tone filter 226 to the receiving detector 227 which operates the receiving chain 228. This receiving chain responds to the control tone transmitted from the distant end through the operation of the transmitting chain 214 thereat and, like the transmitting chain, performs a variety of switching functions which will be more fully described hereinafter. At present it is sufficient to say that the receiving chain clears the way for the speech currents to reach the hybrid coil 206 and the channel 201. The speech currents leaving the hybrid coil 225 enter the next hybrid coil 229 and thence pass through a part of the privacy circuit 230, the first receiving suppressor 231, another part of the privacy circuit 232 to the second receiving suppressor 233. From this point the speech currents pass through the variable suppressor 234, a low-pass filter 235, a volume controller 236, a repeater 237, a network 238 and thence to the hybrid coil 206 from which they pass over the channel such as 201 at the said distant terminal.

The functions of these various pieces of apparatus are briefly as follows. The hybrid coil 206 receives voice currents from the channel 201 and transmits them out over channel 208. The hybrid coil 206 also receives voice currents from the channel 239 and transmits them out over channel 201. Actually the voice currents split equally to paths 208 and 239 but are prevented from passing over 239 beyond the repeater 237 by the unidirectional characteristics of this repeater. The function of the balancing network 207 is well known. In this connection it should also be noted that each of the hybrid coils 212, 221, 222, 225 and 229 is provided with an appropriate balancing network. The networks 209 and 238 are provided to perform certain functions necessary in commercial telephone circuits to compensate for the differences in transmission when the channel 201 is connected to different types of telephone circuits. They play no particular part in the present invention as their adjusting circuits are not shown but they are included in the schematic part of this diagram in order to render the diagram as complete as possible. The vogad 211 is a means for adjusting the gain applied to the voice currents incoming thereto so as to provide a substantially uniform level of output. The hybrid coil 212 allows a small part of the voice currents to be taken off to the syllabic amplifier-detector 213 without causing distortion in voice currents flowing from the hybrid coil 212 to the rest of the circuit. The delay circuit 215 is an arrangement by which voice currents are delayed to allow time for the transmitting chain 214 to properly perform its

functions before the voice currents are finally delivered to the antenna **203**. Since these delay circuits entail certain loss in the transmission, amplifying means are associated therewith in the form of a repeater **216** which is shown as a one-way amplifying repeater. The first transmitting suppressor **217** and the second transmitting suppressor **219** both act to block speech currents therethrough when the relays of the transmitting chain **214** are in their normal positions. When, however, the transmitting chain is operated both transmitting suppressor **217** and transmitting suppressor **219** give a clear path for the transmission of voice currents. The two privacy system units **218** and **220** are included to render the speech between the antenna **203** and the distant antenna **204** unintelligible, but do not form any essential part of the present invention, being included again for the purpose of rendering the schematic lay-out as complete as possible. The function of the hybrid coil **221** is to transmit to the hybrid coil **222** either speech coming from the privacy system unit **220** or telegraph signals coming from either the filter **250** or the filter **251**. The function of the hybrid coil **222** is to pass on to the transmitting repeater **223** both the output of the hybrid coil **221** and the control tone originating from either the oscillator **260** or the oscillator **261**. These oscillators are sources of alternating current of frequencies just outside the voice range of the two twin channels explained in connection with Fig. 4 hereinbefore. These tones may be effectually filtered out at the distant receiving end without disturbing the voice currents entering the receiving channel thereat.

Current from either the oscillator **260** or the oscillator **261** enters the control tone enabler **241** which is under control of the transmitting relay chain **214**, as will appear hereinafter. When the voice takes command of the transmitting chain **214** and certain relays in the telegraph transmitting apparatus of Fig. 1 are properly operated, the control tone enabler **241** will allow alternating current from either the source **260** or the source **261** to enter the control tone compressor **242** and from this point the control tone will be passed to the hybrid coil **222**. The effect, therefore, is that when the voice takes command of the transmitting chain **214** control tone at full volume will be delivered to the hybrid coil **222**. A short time thereafter, as measured by the delay circuit **215** and controlled by a connection in the voice path between the first transmitting suppressor **217** and the first unit of the privacy system **218**, the control tone compressor will operate to reduce the volume of the control tone being delivered to the hybrid coil **222**.

The transmitting repeater **223** is a well-known type of one-way amplifier. The radio transmitter **202** and its associated antenna **203** need no special description. Likewise, the radio receiver **205** and its associated antenna **204** need no special description. The repeater **224** is, like the repeaters **216** and **223**, a one-way amplifying device. The hybrid coil **225** receives the output of the radio receiver **205** and allows part of this output to flow to the control tone filters **226** and **243** which deliver to the receiving detector **227** only the control tone.

The hybrid coil **225** also delivers to the next hybrid coil **229** the speech currents, the accompanying control tone being filtered out later. Hybrid coil **229** acts during the transmission of speech currents to deliver the speech currents which are transmitted from the radio receiver **205** to the privacy system unit **230** and the various circuit units thereafter. During intervals of telegraph transmission the hybrid coil **229** delivers the output of the radio receiver **205** to the telegraph receiving apparatus of Fig. 3.

The privacy system units **230** and **232** are used in complement with the privacy system units **220** and **218** to insure secrecy in the transmission of intelligence by translating for delivery to channel **201** the otherwise unintelligible transmission from the antenna **203** to the antenna **204**. The first receiving suppressor **231** and the second receiving suppressor **223** both operate under control of the receiving relay chain **228** to block the speech path during those intervals when the control tone is absent from the transmission being received by the receiver **205**. When control tone is present as an indication that speech is present, the receiving relay chain **228** is operated and the receiving suppressors **231** and **233** give a clear path for speech currents toward the hybrid coil **206** and the channel **201**. The variable suppressor **234** is a device used to cause the transition from speech to silence and from silence to speech to be slow so that static and extraneous noises will not be applied to and removed from the speech circuit abruptly and so disturb the listener. The low-pass filter **235** effectively blocks any control tone which may have accompanied speech to this point and allows only the speech to go into the volume controller **236**. At this point it should be noted that between the low-pass filter **235** and the volume controller **236** there is a connection to the receiving detector **227**. Thus when the voice takes command at the distant transmitting end, control tone from one of the oscillators **260** or **261** is transmitted by the radio transmitter at full volume and this will enter the control tone filters **226** and **243** and the receiving detector **227** to insure the proper operation of the receiving master relay within the receiving chain **228**. By the time that the voice arrives the receiving chain will have conditioned the receiving circuit, particularly by operating the first and second receiving suppressors **231** and **233** and the variable suppressor **234**. As the control tone is reduced in volume through the action of the control tone compressor **242** or through selective fading in the radio path, voice currents from the connection between the low-pass filter **235** and the volume controller **236** will reach the receiving detector **227** to augment the operation of this device and insure the proper and continuous operation of the receiving chain even during periods when fading or other disturbances in the mutable link cause the received control tone to drop out.

That part of the circuit between and including radio transmitter **202** and radio receiver **205** is spoken of as a mutable link since it comprises a signaling channel capable of or liable to change from internal or external noise which may give rise to interfering energy or, more specifically, subject to noise, fading or change of attenuation. It is to be understood, however, that the present showing is by way of example and that the term "mutable link" does not necessarily mean that a space radio link is invariably involved but that the term is broader in its meaning and includes any channel liable to change from internal or external noise.

The volume controller **236** is a device, generally under the supervision of a technical operator,

for controlling the volume as indicated by a monitoring device (not shown) connected between this unit and the receiving repeater 237. The receiving repeater 237 is, like the other repeaters 216, 223 and 224, a one-way amplifying device.

The syllabic amplifier-detector 213 is a device designed to be unoperated by the maximum noise which may be expected on the transmitting circuit but it will be operated quickly by speech signals of both high and low amplitudes. It is connected to the hybrid coil 212 and delivers its output to the receiving chain 214. If the receiving chain 228 is idle, then the amplifier-detector 213 will be enabled. If at this time voice currents come in over channel 201 their effect will be to operate the amplifier-detector 213 and thereupon to operate the transmitting relay chain 214. The transmitting chain 214 comprises a number of relays which therefore effectually respond to speech. Various lines from the rectangle designated 214 indicate control which this chain has over these other pieces of apparatus. For instance, the transmitting chain has control over the transmitting suppressor 217, the privacy control unit 218 and the transmitting suppressor 219. The transmitting relay shown also has control over the telegraph transmitting apparatus shown in Fig. 1. When the voice takes command and the transmitting chain 214 is operated, a ground connection will be extended by the transmitting chain 214 to the back contact and armature of relay 100, thence through the resistance 101, the winding of relay 102 and the winding of relay 103 to battery. The operation of relays 102 and 103 effectively disables the transmitting telegraph apparatus. The transmitting chain 214 also controls the control tone enabler 241 but this circuit extends through the armature and back contact of relay 104 in the telegraph transmitting circuit so that if the voice takes command at a particular time when relay 104 is operated, the transmission of control tone from either the oscillator 260 or the oscillator 261 will be delayed.

In like manner, the receiving relay chain 228 has control over various circuit units. For instance, the receiving suppressor 233 and the variable suppressor 234 are controlled by this circuit. When the receiving chain 228 is operated then the amplifier-detector 213 is disabled and a control exercised over the vogad 211 to maintain the gain of this apparatus at the point last set. Another line from the receiving chain 228 indicates control exercised over the telegrad 300 by the receiving chain, whereby the telegrad is rendered effective during the periods that the chain 228 is in its normal, unoperated position.

A key 257 controls the transmission and receiving circuits for the spread and unspread conditions. In its normal position, as shown, key 257 causes the lighting of signal lamp 263, indicating the unspread condition. In this condition battery is connected to conductor 259 but conductor 258 is open, and therefore, no one of the relays 255, 256, 262, 265 or 350, connected to these conductors, is operated. With relay 255 unoperated an alternating current of a frequency of 2295 cycles from the oscillator 253 is connected to the signal converter 252. Likewise, with relay 256 unoperated the signal converter 252 is connected through the filter 250 adapted to pass alternating current of 2295 cycles to the hybrid coil 221. With relay 262 unoperated the oscillator 260 will deliver an alternating current of 3000 cycles to the control tone enabler 241. With relay 265 unoperated control tone filter 243 tuned to 3000 cycles is connected to detector 227. With relay 350 unoperated, hybrid coil 229 is connected, through filter 301, to the telegrad 300 and so will pass signals of a frequency of 2295 cycles.

When the key 257 is operated the signal lamp 263 is extinguished and signal lamp 264 is illuminated, thus indicating the spread condition. Key 257 also connects ground to conductor 258, resulting in the operation of relays 255, 256, 262, 265 and 350. At this time a tone source 254, delivering an alternating current of 4590 cycles, is connected to the signal converter 252. Likewise, the signal converter 252 is, through the operation of relay 256, connected through the filter 251 which will pass signals of 4590 cycles to the hybrid coil 221. With relay 262 operated the oscillator 261, delivering an alternating current of 5250 cycles, is connected to the control tone enabler 241. Through the operation of relay 265 the control tone filter tuned to 5250 cycles is now connected to detector 227. Through the operation of relay 350 the hybrid coil 229 is connected, through filter 349, which will pass signals of 4590 cycles, to the telegrad 300.

The key 257 is under control of the technical operator at this terminal and both the key 257 at this terminal and at the similar distant terminal will be operated simulaneously under proper instructions given to the technical operators thereat.

The transmitting telegraph apparatus consists, generally, of a pair of tape transmitters 105 and 106. Each of these transmitters has a series of five contacts operating between a spacing battery lead 107 and a marking battery lead 108 and affecting, in turn, the segments 111 to 120, inclusive, of the multiplex distributor. This latter piece of apparatus consists, in general, of a motor and synchronizing equipment 110 operating a shaft 109. This shaft has upon it a number of brushes 121, 122, 123 and 124. The brush 121 as it passes successively over the segments 111 to 120, inclusive, connects these segments to the ring 125 which is connected through either the armature and back contact of relay 126 or the armature and back contact of relay 127. Thence through the back contact and armature of relay 103 and the winding of the telegraph transmitting line relay 128 to a point on a potentiometer consisting of the resistances 129 and 130 whereby the relay 128 will respond to either marking or spacing potential and thus operate its armature accordingly. When relay 128 is operated by a spacing signal it closes a circuit through its armature and contact to render the signal converter 252 ineffective to transmit telegraph tone from either the source 253 or the source 254 to the hybrid coil 221. When the relay 128 is operated by a marking signal it opens this circuit which controls the signal converter 252 in such a way that alternating current from the source 253 or the source 254 freely passes to the hybrid coil 221 and thence out over the radio transmitter 202.

It should be noted that when the transmitting relay chain 214 is operated and, consequently, relay 103 is operated, that a connection is extended from spacing battery lead 107 through the front contact and armature of relay 103 to the winding of relay 128 to hold this relay spacing and, therefore, continuously to block the

transmission of telegraph tone to the hybrid coil 221.

The function of brush 122 is as follows: If the transmitting chain operates at any time before brush 122 comes in contact with segment 133 or segment 134, then relays 102 and 103 will be properly operated and further transmission of telegraph signals interrupted and the stepping of the tape magnet prevented. If, however, the operation of the transmitting chain 214 occurs while brush 122 is on either of these segments 133 or 134, a connection will be extended from battery, ring 135 over brush 122 to segment 133 and thence through the windings of relays 104 and 100, the back contact and armature of relay 102 to ground. This causes the circuit for the operation of relays 102 and 103 to be opened to prevent the disabling of the telegraph apparatus for this very short interval. This arrangement is provided so that if the voice takes command of the circuit at or during the transmission of the last pulse of a telegraph code, this last pulse may be allowed to be transmitted without interruption.

The function of brush 123 is as follows: The segments and rings of this multiplex distributor are developed for the sake of clarity and the brush 123, now moving downwardly, has reached the point where transmission of the signals from the tape transmitter 106 has been completed. Brush 123 now establishes a connection from ground, ring 136, brush 123, segment 137, back contact and outer right-hand armature of relay 138, winding of stepping magnet 139, right-hand contact and armature of relay 140 to battery. If relay 140 is on its right-hand contact, as it should be while this apparatus is operating normally, and there is a sufficient supply of tape for use by the transmitter 106, then the magnet 139 will operate and advance the tape to the next punched character. As brush 123 advances it next comes into contact with segment 141 where a connection is established from ground, ring 136, brush 123, segment 141, the contacts of the taut tape switch 142, which will be closed as long as there is sufficient tape in this transmitter, to the left-hand winding of relay 138. This connection also extends in parallel through the normal contacts and the inner right-hand armature of relay 138 through the right-hand winding of this relay, and these windings being opposed no operation of the relay 138 will occur. If, however, upon the operation of magnet 139 the taut tape switch 142 had operated, then only the right-hand winding of relay 138 would have been energized and this relay would then have operated and locked through its inner right-hand armature to ground. This condition would have persisted until the taut tape switch 142 closed its contacts again and brush 123 made contact with segment 141 whereupon the relay 138 would have been automatically released.

During the time that relay 138 is operated, each of the segments 116 to 120, inclusive, would have been connected through the front contacts and left-hand armatures of relay 138 to marking battery so that a signal consisting of five marking pulses would have been repeatedly sent each time the brush 125 passed over the segments 116 to 120, inclusive.

When brush 123 advances to segment 143 a connection is momentarily established from ground, ring 136, brush 123, segment 143, the lower winding of relay 140 to battery. This tends to drive relay 140 to its right-hand contact where it will remain unless some other circuit is closed to change this condition.

As brush 123 advances further it first causes the operation of stepping magnet 144 in a similar manner to the operation of stepping magnet 139 and attempts to operate the relay 145 and finally closes a circuit to drive relay 146 to its right-hand armature.

The function of brush 124 is as follows: If during the time that brush 124 is on segment 147 relay 102 becomes operated, then a circuit will be established from ground, the armature and front contact of relay 102, ring 148, brush 124, segment 147, the upper winding of relay 146 to battery. Relay 146 will thereupon be driven to its left-hand contact where it will remain until brush 123 drives it back to its left-hand contact. During the time that relay 146 is on its left-hand contact it will cause the operation of relay 126 in an obvious circuit and thereby open the transmitting circuit which operates the telegraph transmitting relay 128. When brush 124 reaches the lower segment 149 it will cause the relay 140 to move to its left-hand contact whereupon the relay 127 will be operated and complete the opening of the circuit for relay 128. It will be noted that each of these relays 146 and 140 will be periodically returned to its right-hand contact at the ending of the period of activity of the other circuit but if the telegraph transmitting apparatus is now rendered ineffective, the relay will return to its left-hand contact immediately thereafter and before any signals can be effectively transmitted.

It should be noted before leaving the description of the transmitting telegraph apparatus that if both the taut tape switches open the left-hand windings of relays 138 and 145, respectively, that the contacts and the left-hand armatures of relay 145 are connected to spacing battery so that first a series of five marking impulses and later a series of five spacing impulses will be transmitted. This provides for a repeating transition between five spacing and five marking impulses for the purpose of correcting the distributor speed at the distant end.

When the receiving relay chain 228 is in its normal unoperated condition, then the telegrad 300 will be enabled. This will render the telegrad effective to operate the receiving telegraph apparatus. At this time telegraph signals being received by the radio receiver are passed into hybrid coil 229 and thence into the band-pass filter 301 or band-pass filter 349 from which they are delivered to the telegrad 300. This results in the operation of relays 302, 303 and 304 to their marking contacts for each marking impulse delivered to the telegrad 300. Relay 302 is known as the receiving telegraph line relay and for each marking impulse it establishes a ground connection to the ring 305. Relay 304 is known as the corrector relay. Upon each spacing impulse this relay will cause its condenser 306 to be energized and upon each marking impulse this relay will deliver the condenser discharge into ring 307. Relay 303 is known as the auxiliary relay and operates on each marking impulse to drive either relay 308 or relay 309 to its left-hand contact, respectively.

The receiving telegraph apparatus consists, generally, of two printers 310 and 311 and a multiplex distributor comprising a motor and certain synchronous equipment 312 operating a shaft 313 carrying brushes 314, 315, 316 and 317.

As brush 314 moves downwardly it connects

the ring 305 through segments 318, 319, 320, 321 and 322 to the selecting magnets of printer 311 and thereafter through segments 323, 324, 325, 326 and 327 to the selecting magnets of printer 310. Thus for each marking impulse one of the selecting magnets of printer 311 or printer 310 is operated.

Brush 316 in moving downwardly makes contact with segments 328 and then 329 while brush 314 is traversing the connections to the selecting magnets of printer 311. The segments 328 and 329 are associated with printer 310. The connection to segment 328 establishes a circuit from ground, ring 330, brush 316, segment 328, armature and contact of relay 308 to the printing magnet 331. Thus the selection set up on printer 310 is rendered effective by the printing magnet 331 after the brush 314 has completely traversed the segments 323 to 327 and is now engaged in passing over the segments 318 to 322. As the brush 316 advances it makes a connection from ground to segment 329, which leads to the lower right-hand set of contacts of key 332, for purposes which will be hereinafter described.

As brush 316 next traverses segment 333 the printing magnet 334 will be operated.

Brush 317 makes contact from the ring 335 to the segment 336 during the time that the brush 314 is traversing the segments associated with the printer 311. This circuit from ring 335 extends a battery connection to the two windings of the relay 309 through the rectifiers 337 and 338. If this telegraph receiving apparatus is now properly in operative condition, there will be an open connection to the upper winding of this relay at the armature and contact of relay 339. Any marking impulse coming in at this time will be rendered effective by the auxiliary relay 303 to keep relay 309 on the left-hand contact and thus render the printing magnet effective. If, on the other hand, the receiving chain 228 is operated by voice currents, then relay 339 will be released and ground on the armature of relay 339 will cause relay 309 to be driven to its other position where the circuit for printing magnet 334 is opened. Similar action of relay 308 will take place when the brush 317 traverses the segment 341.

It will also be noted that when the relay 339 is operated, as when the receiving chain 228 is in its normal position, thus denoting the fact that the receiving telegraph apparatus is effective, that relay 340 will be operated. Relay 340 plays a particular role with relation to the key 332.

If the distant transmitter corresponding to transmitter 106 operates its taut tape switch so as to send out a series of five marking impulses, then the receipt of these five marking impulses by the printer 310 results in a thumping of the teletypewriter apparatus without the production of any printing. If this becomes annoying to the operator, then the key 332 may be moved to its right-hand position. Thereupon a circuit will be established from battery, the upper right-hand contacts of key 332, the winding of relay 342, the lower right-hand contacts of key 332 to the segment 329 and when brush 316 makes contact with segment 329 a connection is extended to ground on ring 330. This causes relay 342 to operate and this relay locks up to battery on its inner right-hand armature. Relay 342 is sufficiently slow in releasing so that it will remain locked up in a manner now to be described. Upon the first operation of relay 342 a circuit for the operation of relay 343 is closed at the front contact and outer right-hand armature of relay 342. This relay now disconnects the segments 323 to 327, inclusive, from the selecting magnets of the printer 310 and extends them to conductor 344 which, with the left-hand contacts of key 332 in their normal position, extends the ground connection each time the brush 314 connects with a segment 323 to 327, inclusive, to the winding of relay 342 to maintain this relay operated.

If at the distant end the taut tape switch should return to normal, then ground impulses will not be supplied to the winding of relay 342 at sufficient intervals to keep this relay operated and it will therefore release and by releasing cause relay 343 to return to normal, so that the printer 310 again becomes effective. If during the time that relay 342 is locked up the receiving telegraph apparatus is rendered ineffective by the operation of the receiving chain 228, then relay 340 returns to normal and this maintains relay 342 locked up until the telegraph apparatus is again rendered effective through the operation of the receiving chain 228.

The relay 342 may be unlocked at any time by moving the key 332 to its left-hand position.

As brush 315 moves it alternately makes contact with segments connected to either conductor 345 or 346. These conductors are connected to different windings of the auxiliary-corrector relay 347 and therefore the discharge of the condenser 306 will tend to operate the relay 347 in one direction if the motor 312 is running fast or operate the relay 347 in the other direction if the motor 312 is running slow. The correcting means is well known and will not be further described except to note that a device 348, which will indicate fast or slow operation, is inserted at this point to indicate that correction may be properly made.

What is claimed is:

1. In a communication system, a plurality of transmission channels comprising a carrier and means for utilizing portions of the side-bands thereof for transmission purposes, one channel including a limited band of frequencies on one side of and close to the carrier and another channel including a different limited band of frequencies on the other side of and relatively distant from the carrier, control and signaling means for each said channel comprising sources of alternating current, one of a frequency outside the said limited band and another of a frequency within the said limited band and controlling circuit devices including filtering networks for said control, and signaling currents and switching means for alternatively rendering the said control and signaling means for either said channel effective.

2. In a communication system wherein a first type of transmission is interpolated in a second type of transmission during lulls and pauses in said second type of transmission, twin transmission channels comprising a carrier and means for utilizing portions of the side-bands thereof for transmission purposes, one of said twin channels including a limited band of frequencies on one side of and close to the said carrier and the other of said twin channels including a different limited band of frequencies on the other side of and relatively distant from the said carrier, control means for each said channel for said second type of transmission comprising sources of alternating current outside said limited bands of fre-

quencies and tuned controlling devices including filtering networks corresponding thereto, signaling means for each said channel for said first type of transmission comprising sources of alternating current within said limited bands of frequencies and tuned controlling devices including filtering networks corresponding thereto, and switching means for alternatively rendering said control and signaling means for either said channel effective.

3. In an interpolated telephone and telegraph system wherein telegraph signals are interpolated in telephone conversations during lulls and pauses therein, a twin channel transmission system comprising a carrier and means for utilizing portions of the side-bands thereof for transmission purposes, one of said twin channels including a limited band of frequencies on one side of and close to the said carrier and the other of said twin channels including a different limited band of frequencies on the other side of and relatively distant from the said carrier, interpolating control means for each said twin channel for simultaneous use with the telephone facilities of said system comprising sources of alternating current each outside the corresponding said limited band of frequencies and tuned controlling devices including filtering networks corresponding thereto, telegraph signaling means for each said twin channel for use during the lulls and pauses in the telephone conversation comprising sources of alternating current each within the corresponding said limited band of frequencies and tuned controlling devices including filtering networks corresponding thereto, and switching means for alternatively rendering said control and said signaling means for either said channel effective.

4. In an interpolated telephone and telegraph system wherein telegraph signals are interpolated in telephone conversations during lulls and pauses therein, a terminal comprising transmitting and receiving means, transmission channels for associating said transmitting apparatus with distant receiving apparatus and said receiving apparatus with distant transmitting apparatus, each said transmission channel comprising a twin channel transmission system comprising a carrier and means for utilizing portions of the side-bands thereof for transmission purposes, one of said twin channels including a limited band of frequencies on one side of and close to the said carrier and the other of said twin channels including a different limited band of frequencies on the other side of and relatively distant from the said carrier, the carriers for said transmitting and receiving channels of said terminal being different and the frequency characteristics of said twin channel side-band channels being alike, interpolating control means for each said twin channel for simultaneous use with the telephone facilities of said system comprising sources of alternating current each outside the corresponding said limited band of frequencies associated with the transmitting circuits of said terminal and tuned controlling devices including filtering networks corresponding thereto associated with the receiving circuits of said terminal, telegraph signaling means for each said twin channel for use during the lulls and pauses in the telephone conversation comprising sources of alternating current each within the corresponding said limited band of frequencies associated with the transmitting circuits of said terminal and tuned controlling devices including filtering networks corresponding thereto associated with the receiving circuits of said terminal, and switching means individual to said terminal for alternatively rendering said control and signaling means for either said channel effective.

5. The method of operating a system of transmission which includes means for transmitting and receiving a carrier wave modulated in accordance with a signal current and a control current which comprises at one time transmitting an essentially single side-band modulated wave in which the signal and control current are on one side of the carrier wave in the frequency spectrum and at another time transmitting an essentially single side-band modulated wave in which the signal wave and control wave are on the other side of the carrier wave in the frequency spectrum and further removed therefrom than in the first case, and changing the transmitting and receiving apparatus at intervals from one condition to the other.

6. The method of transmission with relation to the carrier frequency of an assigned channel which comprises transmitting successively under control of the same source or sources of signals to be transmitted an unspread band on one side of the carrier frequency and a spread band on the other side of the carrier frequency.

7. The method of transmitting speech having telegraph signals interpolated in the silent intervals thereof as a side-band of a carrier wave which comprises at intervals shifting speech and telegraph signals from one side-band of the carrier wave to the other and shifting a receiving apparatus correspondingly at the same time.

8. In a carrier wave transmission system in which signal waves of a special class are accompanied by a convoy current, means for transmitting the convoy current at one time as one side-band of a carrier wave and at another time as the other side-band of the same carrier wave.

9. In a system of carrier wave communication in which a special signal is transmitted with a convoy current, means for shifting the convoy current from one side to the other of a modulated carrier wave and simultaneously shifting the wave representing the special signal from one side to the other of the carrier wave.

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