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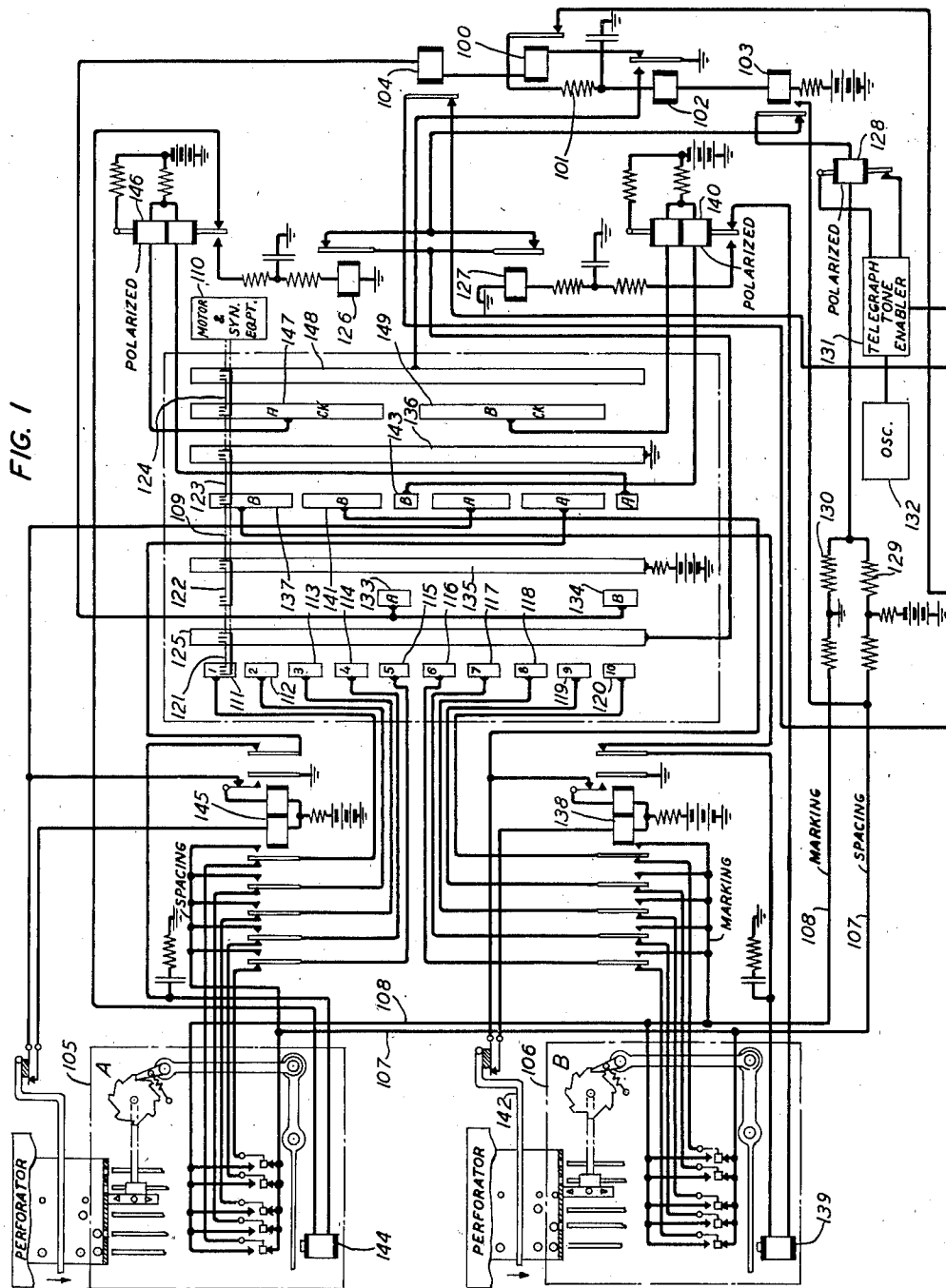
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2,280,871

CONTROL SYSTEM

Filed Aug. 31, 1940

4 Sheets-Sheet 1



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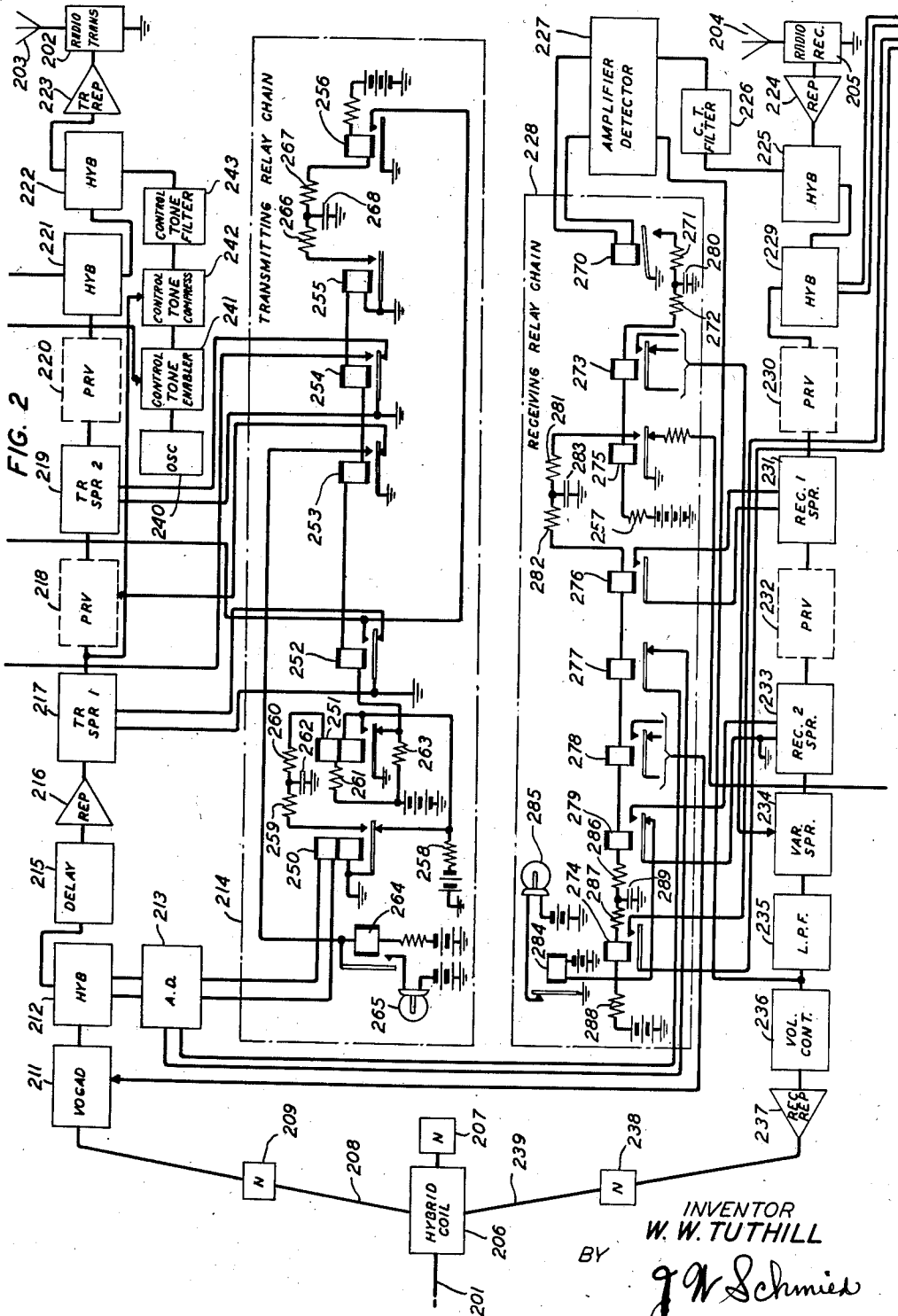
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W. W. TUTHILL
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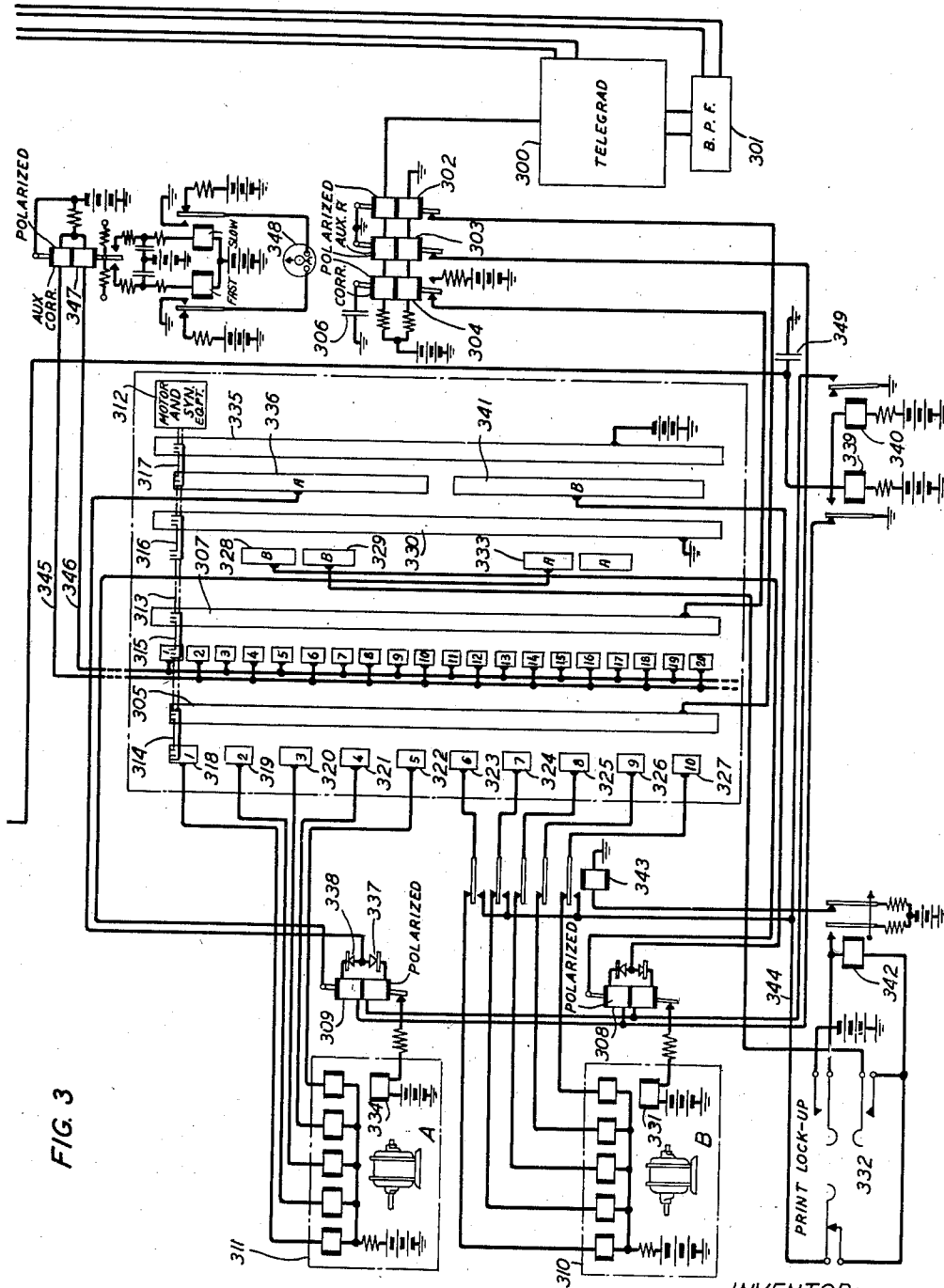


FIG. 3

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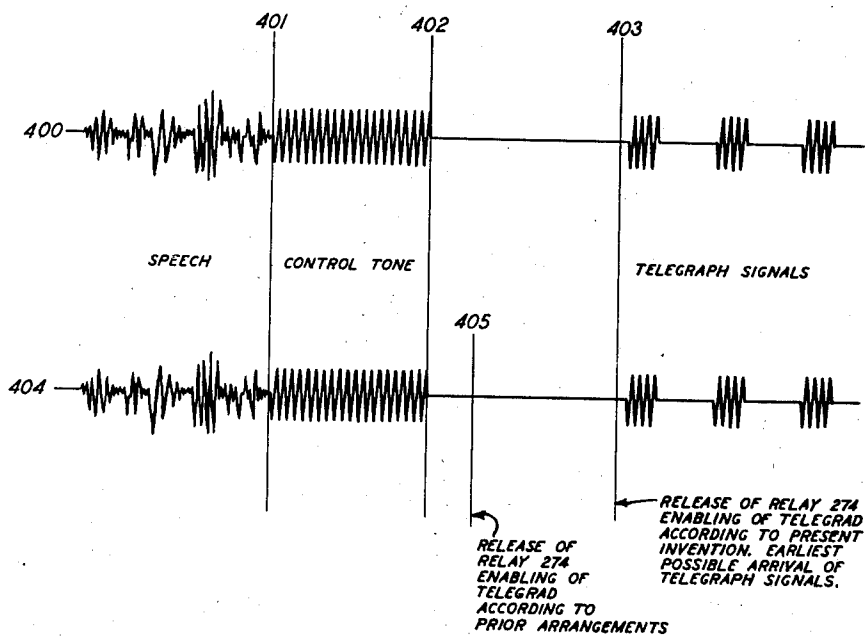
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4 Sheets-Sheet 4

FIG. 4



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CONTROL SYSTEM

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Application August 31, 1940, Serial No. 354,912

4 Claims. (Cl. 179—4)

This invention relates to communication systems and particularly to systems wherein telegraph signals are interpolated in speech during lulls and pauses therein.

In Patent No. 2,238,028, granted April 15, 1941, upon the application of Barney et al., a device known as a telegrad is fully disclosed. This device converts varying strength alternating current signals into equal length uniform strength direct current signals and is useful at the receiving end of a transmission channel including a mutable link.

The telegrad has features of similarity to the well-known vogad (voice operated gain adjusting device) shown, for instance, in Patent 1,853,974, granted April 12, 1932, to Hogg et al., Patent 1,936,653, granted November 28, 1933, to Bjornson et al., Patent 2,012,810, granted August 27, 1935, to S. Doba, and Patent 2,156,622, granted May 2, 1939, to S. Doba.

The telegrad, however, is designed to be extremely quick acting in comparison to the vogad and comprises means whereby this quick action may be accomplished.

Due to the action of the mutable link and other causes such a transmission channel may at times deliver to the telegrad electrical disturbances, spoken of as noise, of a level high enough to be converted by the telegrad into signals, which will result in false operation of telegraph apparatus at the output of the telegrad.

Heretofore the normal operation of a system employing a telegrad subjected such telegrad to intervals during which only such noise could reach the telegrad with the result that false operation of telegraph apparatus occurred.

Where telegraph signals are interpolated in speech during lulls and pauses therein there is provided at the transmitting end of a transmission channel a transmitting chain of relays responsive to voice control. It is the function of these relays to carry out several switching operations when the voice takes command of the circuit and when the voice relinquishes such command. Various timed operations are provided known as hang-over periods. Thus when the voice relinquishes command of the circuit there is first a transmitting hang-over period during which the remote control of the switching at the distant end is maintained so that if the speech comes on again within such hang-over time unnecessary switching operations which otherwise would become too frequent will not be carried out. Following this there is an additional hang-over time provided before the

end of which telegraph transmission under the most favorable conditions cannot be started. These hang-over times are reflected in the operation of the receiving chain of relays at the distant end of the transmission channel. There a telegrad disabler relay is included in the receiving chain whose function it is to maintain the telegrad disabled during the operation of the chain. Therefore at the end of the transmitting hang-over period when the remote control of the receiving chain is relinquished by the distant transmitting chain and after the short hang-over period of the complete receiving chain the telegrad disabler relay releases and allows the telegrad to become enabled. Thereafter and until the earliest possible opportunity for the arrival of telegraph signals the enabled telegrad is subjected to any spurious signals caused by noise or otherwise coming in over the transmission channel so that a fair opportunity for false operation of the telegraph apparatus beyond the telegrad is given.

The object of the present invention is to minimize the opportunity for false operation of telegraph apparatus in a communication system employing voice controlled switching means. Accordingly, the telegrad disabler relay is placed at the extreme end of the receiving relay chain where it can be provided with a hang-over circuit whereby the telegrad may be maintained disabled until the earliest possible beginning of telegraph signal reception thus greatly reducing the opportunity for false operation of telegraph apparatus responsive to the said telegrad.

A feature of the present invention is a control means for a receiving telegraph signal circuit which may be accurately operated to enable the said receiving circuit only just before the arrival of telegraph signals.

The drawings consist of three sheets of circuit diagrams and one sheet containing diagrams in the form of graphs. 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; and

Fig. 4 is a pair of diagrams made from graphs of current plotted against time to illustrate the timing relations of certain circuit operations.

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 spit, 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 pass 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 219, and another part of the privacy circuit 220 to the hybrid coil 221. Speech currents then pass to the hybrid coil 222, thence to the transmitting repeater 223 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 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 the channel 208. The hybrid coil 206 also receives voice currents from channel 239 and transmits them out over channel 261. 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 are provided with appropriate balancing networks. 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 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 the voice currents flowing from the hybrid coil 212 to the rest of the circuit. The delay circuit 15 is an arrangement by which voice currents are delayed to allow time for the transmitting chain 211 to properly perform its functions before the voice currents are finally delivered to the antenna 203. Since these delay circuits entail certain loss in 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 the position shown. 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. It is necessary to use a blocking path at each terminal of the privacy system circuit 218, this being a controlling agency for the other part of the privacy system 220. These two 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 layout 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 Fig. 1 above. 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 the oscillator 240. This oscillator is a source of alternating current of a frequency just outside the voice range so that it may be effectually filtered out at the receiving end without disturbing the voice currents entering the receiving circuit thereat.

Current from the oscillator 240 enters the control tone enabler 241, which is under control of the transmitting 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 the source 240 to enter the control tone compressor 242 and from this point the control tone will be

passed through the filter 243 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 filter 226 which delivers 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, like the privacy system units 220 and 218, are used 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 233, both operate under control of the receiving chain 228, operate 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 chain 228 takes the position shown by the various relays and the receiving suppressors 231 and 233 give a clear path for speech currents toward the hybrid coil 206 and the channels 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 clicks and unpleasant operation of the circuit will not disturb the listener. The low-pass filter 235 effectually 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 the oscillator 240 is transmitted by the radio transmitter at full volume, and this will enter the control tone filter 226 and the receiving detector 227 to insure 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 so that as the control tone is reduced in volume through the action of the control tone compressor 242, voice currents from the connection between the low-pass filters 235 and 236 will reach the receiving detector 237 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 to a value where the continued operation of the receiving chain might be unsatisfactory.

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 cause 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 cause.

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 which will be unoperated by the maximum noise which may be expected on the transmitting circuit but 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 in the position shown 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 operate the transmitting chain 214.

The transmitting chain comprises a transmitting master relay 250 and a chain of relays 251, 252, 253, 254, 255 and 256. The transmitting master relay 250 responds directly to the amplifier detector 213. The relays 250 and 251 together provide an accelerating circuit for the sure and speedy operation of the remainder of the chain of relays. It will be noted that the lower windings of both relays 250 and 251 are included in a series circuit which extends from ground connected also to the armature of relay 250 through the lower windings of relays 250 and 251 and thence to a resistance 258 and battery. However, the connection between the lower winding of relay 251 and the resistance 258 extends to the back contact of relay 250 which, as before stated, is connected to ground. Therefore, the lower windings of relays 250 and 251 are normally short-circuited. When relay 250 operates, then the instant that the armature leaves its back contact the circuit from ground through the resistance 258 to battery is rendered effective and the lower windings on these relays are so designed that the current flowing in this circuit will cause the relays to attract their armatures strongly and with the utmost speed. When relay 251 moves its armature into connection with its front contact, the two lower windings of these

relays are again short-circuited but by that time the relay 250 will have moved its armature to its front contact and relay 251 will have become fully operated. Relay 251 is now held operated in a circuit from ground, the armature and front contact of relay 250, resistance 259, resistance 260, the upper winding of relay 251, resistance 261 to battery.

It should be noted that when under influence of the amplifier detector 213 the transmitting master relay 250 becomes deenergized that the armature of relay 250 will reach its back contact and again establish the original circuit for shunting the two lower windings of relays 250 and 251 before relay 251 can release its armature. Relay 251 is known as the transmitting voice hang-over relay and through the operation of the circuit including condenser 262 and resistance 263 this relay is caused to hold its armature operated until condenser 262 can become sufficiently charged. By the proper selection of the values of resistance 260 and condenser 262, the hang-over period by which the release of relay 251 is delayed beyond the release of relay 250 may be adjusted to any desired value.

Thus the accelerating circuit operates only on the forward operation of these relays 250 and 251 and plays no part in the release thereof.

The operation of relay 251 causes the operation of relays 252 to 255, inclusive. Relays 252 to 255, inclusive, have their windings in a series circuit extending to the back contact and armature of relay 251 and from this point extending also through resistance 263 to battery. Since the armature of relay 251 is grounded, the circuit through the windings of relays 252 to 255 normally is shunted. However, as soon as the relay 251 moves its armature from its back contact, the circuit through the resistance 263 will become effective and relays 252 to 255 will immediately become operated. Through the operation of relay 255, relay 256 is operated.

Relay 252 in its normal position affects the first transmitting suppressor 217 to block voice currents delivered to it by the repeater 216. Upon its operation, however, relay 252 changes this condition so that the first transmitting suppressor 217 now enables the free transmission of voice currents. Relay 253 is the privacy relay and this causes certain switching functions to take place when speech is to be transmitted out over antenna 203. The privacy relay 253 also functions on its front contact to operate the transmitting signal relay 264 and thus the signal lamp 265 to indicate that the transmitting chain is in operation. The relay 254 controls the second transmitting suppressor 219 and relay 255 functions to cause the operation of the transmitting telegraph enabler relay 256. This relay is provided with a hang-over circuit comprising the resistances 266 and 267 and the condenser 268 so that the transmitting telegraph enabler relay does not become released for a given period after the remainder of the transmitting chain has released.

It has been noted briefly hereinbefore that the receiving detector 227 is first operated by control tone through the filter 226 at comparatively high volume and later, after the receiving chain 228 has operated, is then controlled by both the control tone at lower volume through the filter 226 and by voice currents coming in over a connection between the low-pass filter 235 and the volume controller 236. The receiving detector normally holds the control master relay 270 op-

erated and when the receiving detector responds to these incoming control tone and voice currents, it allows relay 270 to become deenergized. During the normal condition, then, relay 270 is operated and the chain of relays controlled thereby is in the position shown. Upon the release of relay 270 a circuit is completed from ground, the armature and back contact of master relay 270, resistance 271, resistance 272, the windings of relays 273, and 275 in series, resistance 257 to battery. Upon the operation of relay 275 a connection is established from ground, armature and front contact of relay 275, resistances 281 and 282 and thence through the windings of relays 276, 277, 278 and 279, resistances 286, 287, relay 274, resistance 288 in series to battery. Resistances 271 and 272 and the condenser 260 form a hang-over circuit so that it is not for a given period after the master relay 270 has again operated that relays 273 to 279, inclusive, may release their armatures. In addition, the resistances 281, 282 and the condenser 283 form a hang-over circuit for relays 276 to 279, inclusive, and relay 274 so that it is not for an additional period after relays 273 and 275 have released that relays 276 to 279 and 274 will release. Furthermore, relay 274 has an individual hang-over circuit consisting of the resistances 287 and 288 and the condenser 289 so that of all the relays of the receiving chain relay 274 is the last to release for a purpose which will presently appear.

Relay 273, known as the receiving suppressor relay, in releasing changes the circuits of the variable suppressor 234 so as to allow what may be termed a gradual opening up of the voice path. Thereafter, in a time interval as measured by the hang-over circuit of resistances 281 and 282, and condenser 283, the receiving suppressor relays 276 and 279 will cause the first and second receiving suppressors 231 and 233, respectively, to fully open up the voice channel to allow voice currents to flow toward the hybrid coil 206. The telegraph relay 274, known as the receiving printing master relay, controls the printer circuit in Fig. 3. The receiving echo hang-over relay 271 controls the amplifier detector 213 at the same terminal and the vogad disabler relay 278 controls the vogad 211 so that while speech is being received at the transmitting terminal, the vogad 211 will be unable to transmit outgoing and, therefore, interfering speech. Relay 279 when released causes the operation of relay 284 and in turn the glowing of lamp 285, as a signal that the receiving chain is effectively operated.

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 123 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 telegraph tone enabler 131 ineffective to transmit telegraph tone from the source 132 to the hybrid coil 221. When the relay 128 is operated by a marking signal it opens this circuit which affects the telegraph tone enabler 131 in such a way that alternating current from the source 132 freely passes to the hybrid coil 221 and thence out over the radio transmitter 202.

It should be noted that when the transmitting 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 from the source 132 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 an occasional transition between a spacing and a marking impulse for the purpose of correcting the distributor speed at the distant end.

When the receiving 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 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. Re-

lay 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 is 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 323 and 329 are associated with printer 310. The connection to segment 323 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 its 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 303 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 typewriter 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 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.

Referring now to Fig. 4 it will be noted that two sets of graphs of current plotted against time are shown. On line 400 as a base line are shown speech current, control current and telegraph current in proper time relation at the transmitting end, that is, speech currents are shown along the line 400 until the vertical 401 is reached. This line represents the time at which speech ceases and the time therefore at which the syllabic amplifier detector 213 releases the transmitting chain 214. Due to the transmitting hang-over time provided by the slow release of relay 251 through the agency of the hang-over circuit consisting of resistance 260 and condenser 252, the control tone enabler 241 will continue to allow control tone from the source 240 to be transmitted until the time represented by the vertical line 402 is reached. Thereafter a period which along the horizontal line 400 appears to be blank is provided by the slow release of the transmitting

telegraph enabler relay 256 through the agency of the hang-over circuit provided by the resistance 267 and condenser 268. This extends to the time marked by the vertical line 403. This line then represents the earliest possible time at which telegraph signals may be transmitted.

The second horizontal line 404 represents the action in the receiving circuit. Speech it will be noted will be received up to the time denoted by the vertical line 401 and control tone will be received up until the time denoted by the vertical line 402. Heretofore the telegraph disabler relay 274 was placed in series with and between the relays 273 and 275 and hence its release was controlled by a slight hang-over provided by the resistance 272 and the condenser 280. The time at which this relay therefore released according to prior arrangements is denoted by the vertical line 405. This leaves a space of some considerable time between the vertical time 405 and the vertical time 403 which denotes the earliest possible arrival of the telegraph signals. During this time the receiving telegraph circuit from the line to the printers is open to noise operation and if the action of the mutable link is particularly severe may result in false operation of the printers.

In accordance with the present invention the telegraph disabler relay 274 is placed at the extreme end of the receiving relay chain 228 and provided with an extra hang-over means consisting of the resistance 287 and condenser 289. This shifts the release of relay 274 to the time denoted by the vertical line 403 so that the enabling of the telegraph will not be accomplished until the earliest possible time at which telegraph signals might arrive.

What is claimed is:

1. In a communication system wherein telegraph signals are interpolated in voice current transmission during lulls and pauses therein, a transmission channel, voice controlled means at the transmitting end of said transmission channel comprising a transmitting chain of relays for performing interpolating switching operations, one of said relays exercising a remote control over a receiving chain of relays at the receiving end of said transmission channel, another of said relays in said transmitting chain operating to control the transmission of telegraph signals, said last relay being provided with a hang-over circuit to time the earliest possible start of telegraph signal transmission a predetermined time interval after the said first relay has relinquished its said control over said receiving chain of relays, telegraph signal responsive means at the receiving end of said transmission channel, said receiving chain including a relay for enabling said telegraph signal responsive means, and a hang-over circuit for said enabling relay arranged to prevent the enabling of said telegraph signal responsive means until the said time for the earliest possible start of telegraph signal transmission.

2. In a communication system wherein telegraph signals are interpolated in voice current transmission during lulls and pauses therein, a transmission channel including a mutable link, voice controlled means at the transmitting end of said transmission channel comprising a transmitting chain of relays for performing interpolating switching operations, a first of said relays exercising a remote control over a receiving chain of relays at the receiving end of said transmission channel, a second of said relays in said

transmitting chain operating to control the transmission of telegraph signals, said second relay being provided with a hang-over circuit to time the earliest possible start of telegraph signal transmission a predetermined time interval after said first relay has relinquished its said control over said receiving chain of relays, telegraph signal responsive means at the receiving end of said transmission channel having a sensitivity rendering it capable of responding to serious spurious disturbances originating in said mutable link, said receiving chain including a relay for enabling said telegraph signal responsive means and means for minimizing the effect of said spurious disturbances upon said telegraph signal responsive means comprising a hang-over means for said enabling relay for synchronizing its said enabling action with the action of said second of said relays in said transmitting chain.

3. In a communication system wherein telegraph signals are interpolated in voice current transmission during lulls and pauses therein, a transmission channel including a mutable link, voice controlled means at the transmitting end of said transmission channel comprising a transmitting chain of relays for performing interpolating switching operations, a first of said relays operating to connect a source of control tone to said transmission channel for transmission thereover, a second of said relays in said transmitting chain operating to start and stop the transmission of telegraph signals over said channel, said second relay being provided with a hang-over circuit to time the earliest possible start of telegraph signal transmission a predetermined time interval after said first relay has disconnected said source of control tone from said channel, a receiving chain of relays at the receiving end of said transmission channel responsive to control tone for performing interpolating switching operations thereat, telegraph signal responsive means at the receiving end of said transmission channel having a sensitivity rendering it capable of responding to spurious disturbances originating in said mutable link, said receiving chain including a relay for enabling said telegraph signal responsive means and means for minimizing the effect of disturbances arising in said mutable link on said telegraph signal responsive means comprising a hang-over circuit for said enabling relay arranged to prevent the enabling of said telegraph signal responsive means for a period corresponding to said hang-over circuit time of said second relay in said transmitting chain.

4. In a communication system wherein telegraph signals are interpolated in a voice current transmission during lulls and pauses therein, a transmission channel including a mutable link, voice controlled means at the transmitting end of said transmission channel comprising a transmitting chain of relays for performing interpolating switching operations, a first of said relays operating to connect a source of control tone to said transmission channel for transmission thereover, a voice current delay circuit for delaying the transmission of voice currents over said channel to give said control tone a time preference in transmission over said channel, means responsive to said delayed voice currents for reducing the volume of control tone transmitted over said channel under control of said first relay, a hang-over circuit for said first relay for maintaining the flow of control tone over said transmission channel for a predetermined period after the stoppage of voice currents, a second of said re-

lays in said transmitting chain operating to start and stop the transmission of telegraph signals over said channel, said second relay being provided with a hang-over circuit to time the earliest possible start of telegraph signal transmission a predetermined time interval after said first relay has disconnected said source of control tone from said channel, a receiving chain of relays at the receiving end of said transmission channel primarily responsive to control tone and secondarily responsive to voice currents for performing interpolating switching operations thereat, telegraph signal responsive means at the receiving end of said transmission channel having a sen-

sitivity rendering it capable of responding to spurious disturbances originating in said mutable link, said receiving chain including a relay for enabling said telegraph signal responsive means and means for minimizing the effect of disturbances arising in said mutable link on said telegraph signal responsive means comprising a hang-over circuit for said enabling relay arranged to prevent the enabling of said telegraph signal responsive means for a period corresponding to said hang-over circuit time of said second relay in said transmitting chain.

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