June 9, 1942. A. E. MELHOSE 2,285,451

AUTOMATIC CONTROL SYSTEM

Filed Aug. 31, 1940 4 Sheets-Sheet 1

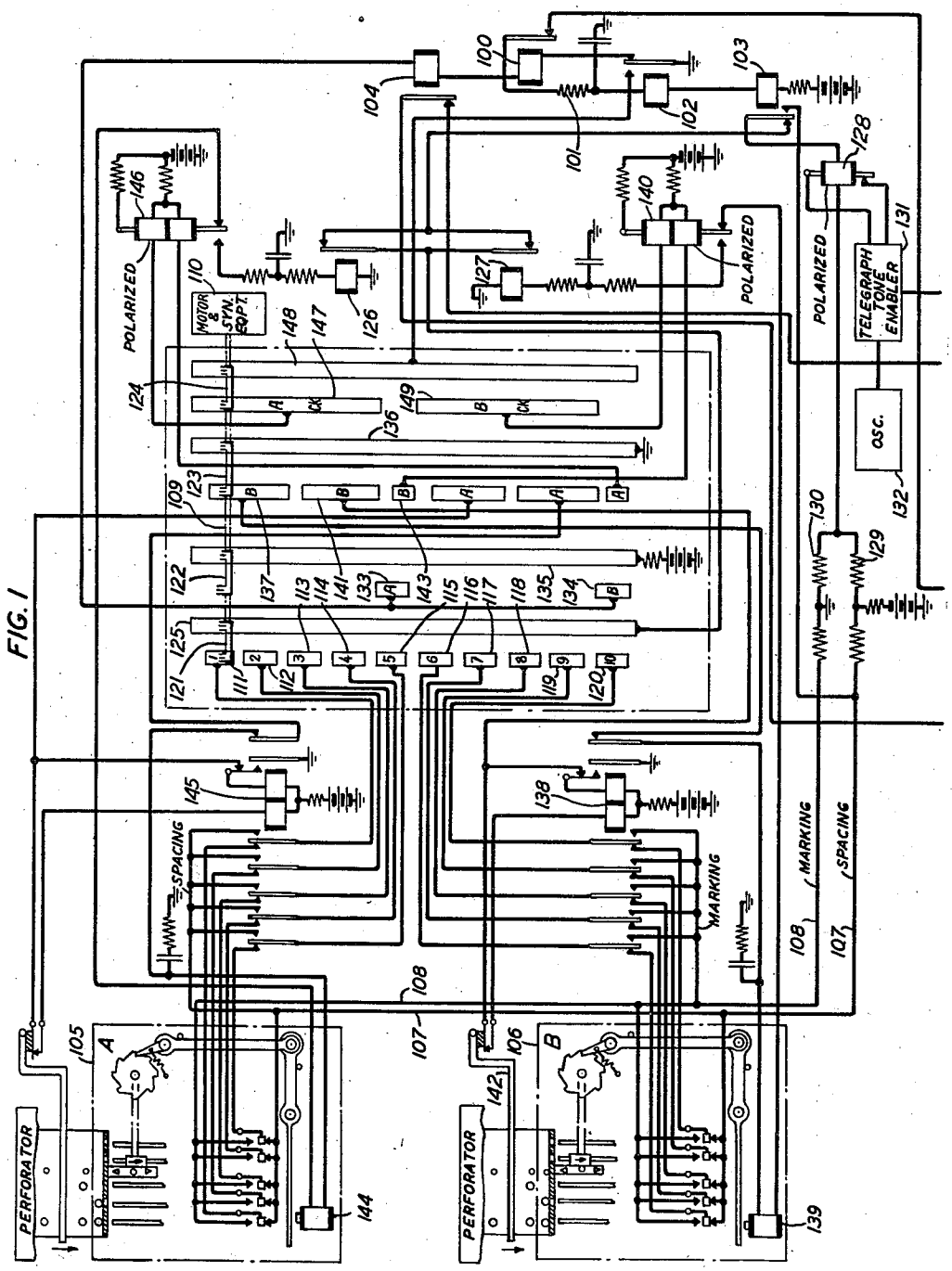

FIG. 1

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AUTOMATIC CONTROL SYSTEM

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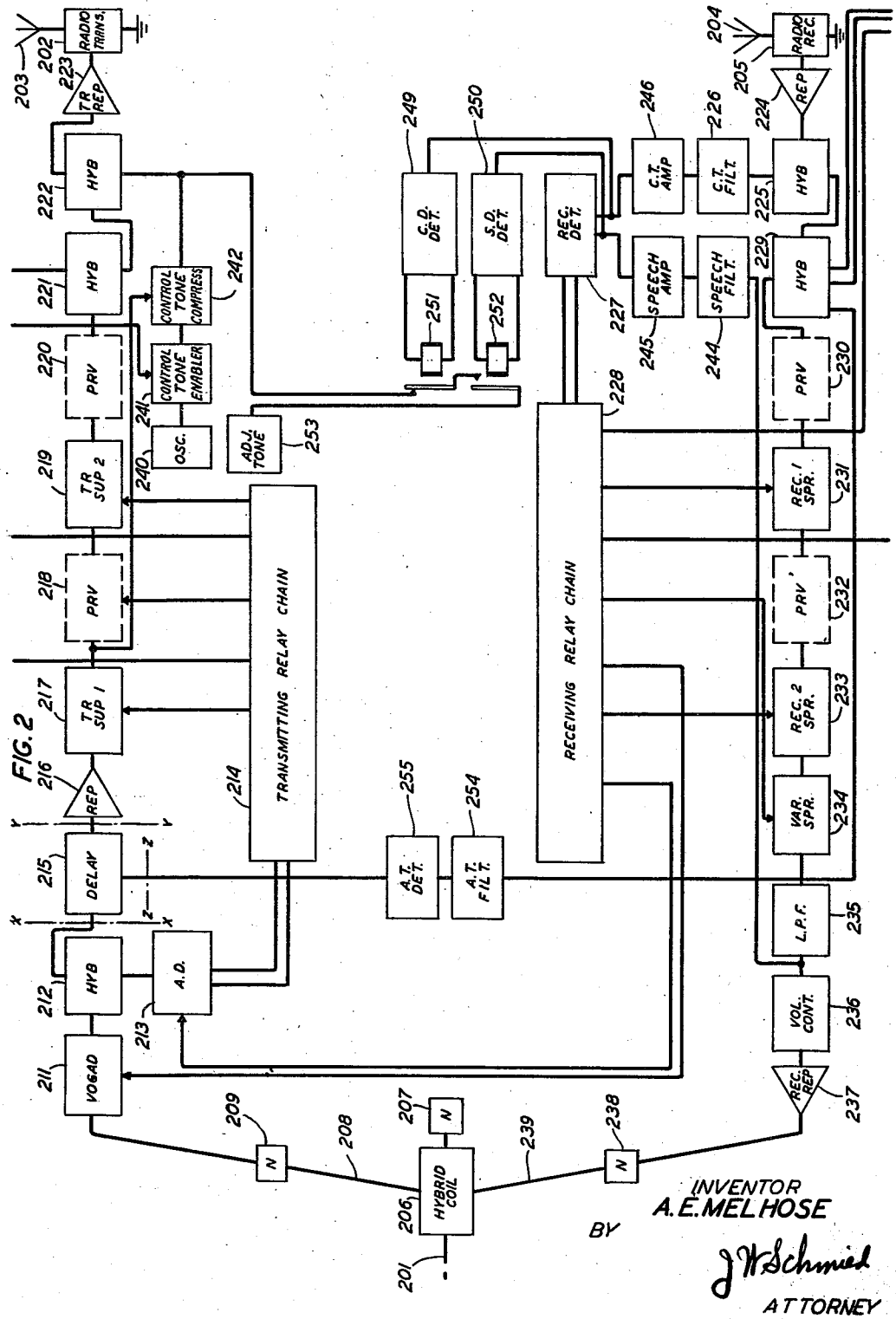

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AUTOMATIC CONTROL SYSTEM

Filed Aug. 31, 1940 4 Sheets-Sheet 3

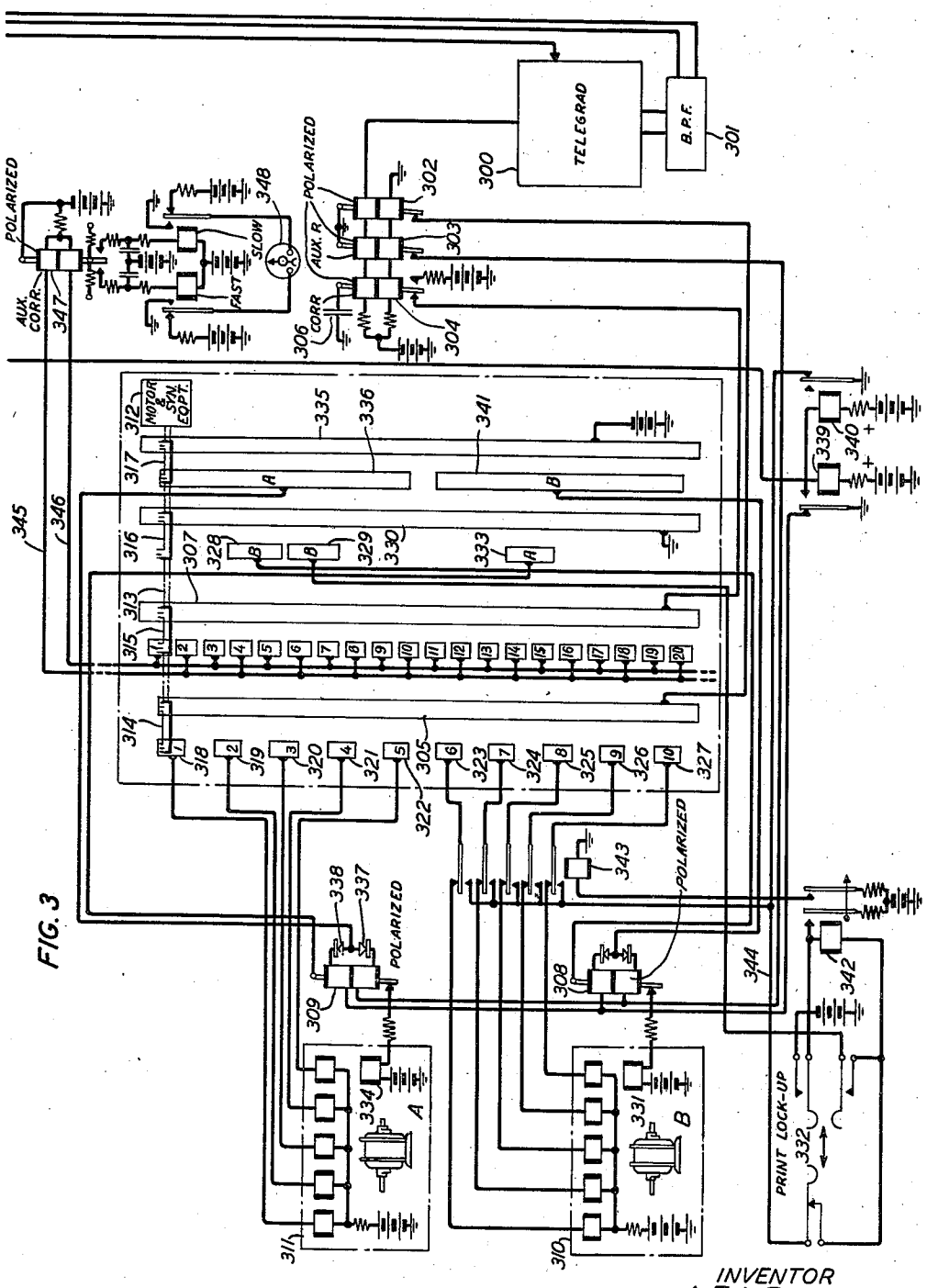

FIG. 3

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AUTOMATIC CONTROL SYSTEM

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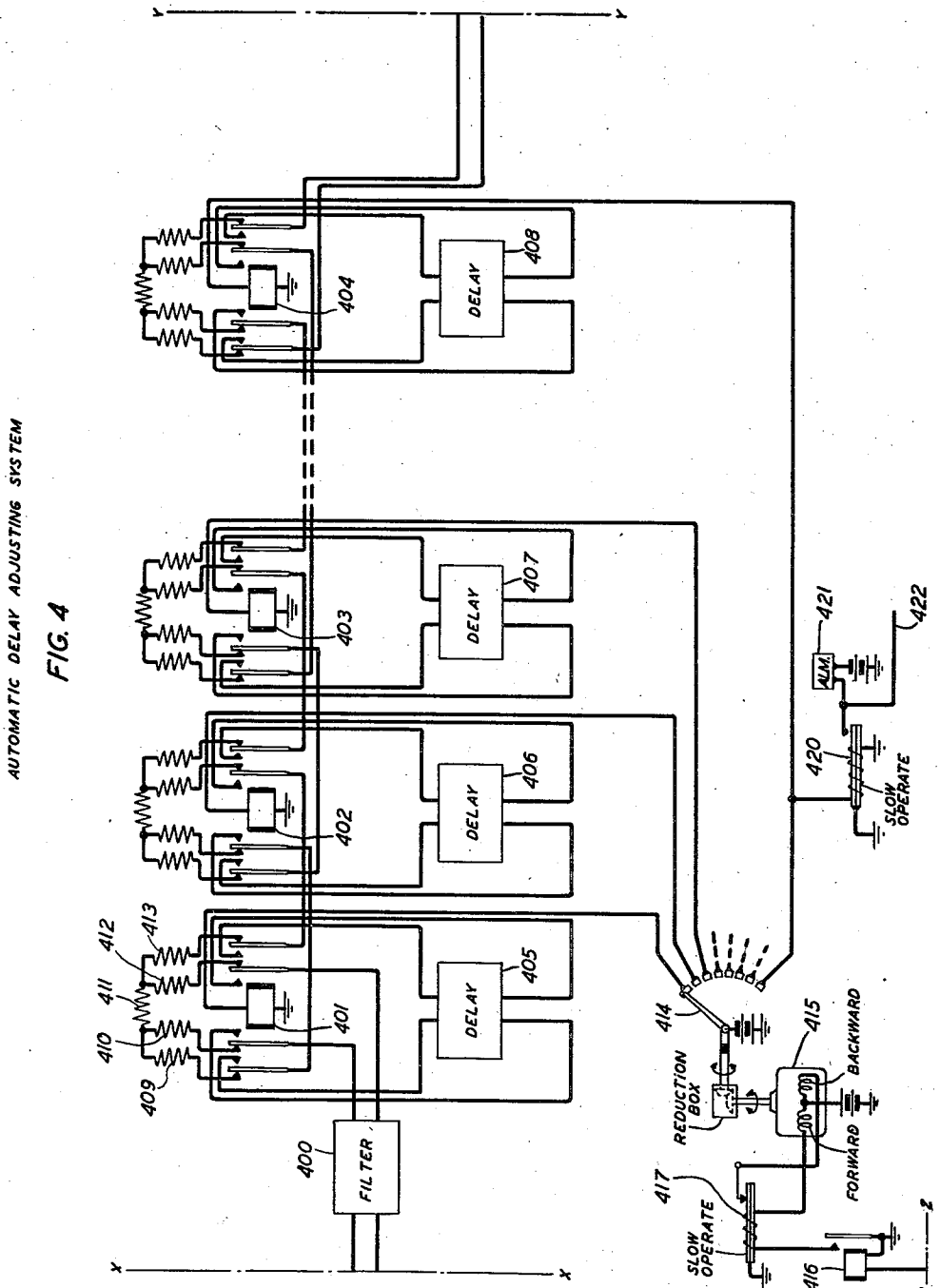

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UNITED STATES PATENT OFFICE

2,285,451

AUTOMATIC CONTROL SYSTEM

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Application August 31, 1940, Serial No. 354,989

16 Claims. (Cl. 179—4)

This invention relates to communication systems and particularly to telephone systems subject to clipping of speech through tardy voice current switching.

In systems of this nature where for various reasons the transmission channel is normally conditioned against the transmission of voice currents, voice current responsive means is provided to switch the channel into condition for the transmission of voice at both the transmitting and the receiving end of the channel. At the same time voice current delay means are provided to retard the transmission of voice currents until this switching operation has been completed. If for any one or more of several known reasons the switching operation becomes tardy then the phenomenon known as clipping occurs and this manifests itself as mutilation of the speech through loss of the beginning of syllables of speech.

For various reasons it is highly desirable to make this voice current delay as small as possible but variable conditions affecting the operation of these circuits render it necessary to set this delay at a value high enough to meet the worst expected condition. Since these periods of maximum disturbance do not occur with great regularity it becomes desirable to provide adjustable means whereby the voice current delay may be varied to suit these varying conditions.

The object of the present invention is to improve the operation of communication systems subject to the clipping of speech by varying the transmitting conditions of a transmission channel in accordance with the varying conditions affecting this undesirable phenomenon.

A feature of the present invention is an adjustable voice current delay circuit arrangement which may be automatically adjusted in conformity with the varying conditions from which clipping of speech arises.

Another feature is a means for automatically and continuously adjusting the voice current delay to a minimum value and in response to the occurrence of this phenomenon to interrupt this automatic and continuous operation and to adjust such delay to a higher value.

Another feature of the invention is a detecting circuit responsive to tardy switching and further responsive to conditions liable to result in tardy switching.

Still another feature of this invention is a motor driven voice current delay circuit adjusting device at the transmitting end of a transmission channel automatically responsive to conditions giving rise to clipping at the receiving end of said transmission channel whereby adjustment to a higher value of delay will be made until clipping ceases.

Another feature of the invention is a detecting circuit responsive to the presence at the receiving end of the transmission channel of both control tone and voice currents and which will give an indication when the voice currents cause an operation prior to the operation caused by the control tone. Further this detecting circuit will give an indication responsive to a further operation caused by the control tone subsequent to an initial proper sequential operation caused by said control tone and the voice currents.

Another feature of this invention is the use of a different control tone for transmission from the receiving end to the transmitting end of a transmission channel in response to an unstandard sequential operation at the receiving end under control of switching control tone and voice currents for controlling an automatic voice current delay adjusting means at the transmitting end of the said channel.

Another feature is an alarm means connected to the final or maximum delay step of the commutating device. Such an alarm means may be in the form of a simple alarm to call an attendant or it may be of more elaborate nature such as a means to automatically notify the technical attendants at both terminals that some trouble of a serious nature needs immediate attention. The means for notifying the distant technical operator may be of the nature disclosed in the copending application of Hall and Melhose, Serial No. 354,990, filed August 31, 1940, or it may be of the general nature herein disclosed, that is a special tone may be used with appropriate receiving apparatus at the far end.

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

These and other features will be more fully explained in the following description and by means of the appended drawings.

The drawings consist of four sheets of circuit diagrams. With Figs. 1, 2 and 3 placed together a circuit diagram of one terminal of an interpolated telegraph and telephone 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 detailed circuit arrangement of the voice delay means indicated by the rectangle 215 in Fig. 2 and fitted into the general diagram of Fig. 2 at the broken lines X—X, Y—Y and Z—Z.

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 syllable amplifier-detector 213 for control purposes. The output of the amplifier-detector 213 feeds into the transmitting relay 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 current 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 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 and finally to the radio antenna 203.

At the distant receiving end the speech currents transmitted from the radio receiver pass through the receiving repeater 224 and into the hybrid coil 225. At this point the control tone which accompanies speech is diverted through the control tone filter 226 and amplifier 246, to the receiving detector 227 which operates the receiving relay chain 228. This receiving relay chain responds to the control tone transmitted from the distant end through the operation of the transmitting chain thereat and, like the transmitting chain, performs a variety of switching functions which will be more fully described hereinafter. For the 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 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 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 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 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 are in their normal positions. When, however, the transmitting chain is operated, the transmitting suppressor 217 and the transmitting suppressor 219 give a clear path for the transmission of voice currents. It is necessary to use a blocking path for 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 again included 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 oscillator 240. This oscillator is a source of alternating current of a frequency just outside of 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 the 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 the source 240 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 modify 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 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 and amplifier 246 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 current, 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 units 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 under control of the receiving chain 228, operate to block the speech paths during those intervals when the control tone is absent from the transmission being received by the receiver 205. When the control tone is present as an indication that speech is present the receiving chain 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 clicks and extraneous operations of the circuit will not disturb the listener. The low-pass filter 235 effectually blocks any control tone which accompanies 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 through a speech band filter 244 and amplifier 245. 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, the amplifier 246 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 so that as the control tone is reduced in volume through the action of the control tone compressor 242 voice current 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 receiving control tone to drop to a value where control tone alone would be insufficient to operate the receiving chain.

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 an operating 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 239 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 transmitting chain 214. If the receiving chain 228 is in its normal unoperated position 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 chain 214. The transmitting chain controls the transmitting suppressor 217, the privacy system unit 218 and the second transmitting suppressor 219 as indicated by the lines extending from the transmitting relay chain and ending in an arrow-head at these described units. Likewise, the transmitting chain controls the control tone enabler 241, this control extending through the armature and back contact of relay 104 in the transmitting telegraph circuits shown in Fig. 1. The transmitting relay chain 214 also controls the transmitting telegraph apparatus through a control extending to the back contact and armature of relay 100, the resistance 101 and the windings of relays 102 and 103 to battery. The circuits are such that when the voice takes command this latter circuit will be connected in the transmitting relay

chain to ground and hence relays 102 and 103 will be operated to disable the transmitting telegraph apparatus.

In like manner the receiving relay chain exercises its control over the receiving suppressor 231, the receiving suppressor 233 and the variable suppressor 234. A line extending to the syllabic amplifier-detector 213 indicates that the receiving relay chain operates to disable the amplifier-detector 213. A similar line extended to the vogad 211 indicates control of the vogad by the receiving relay chain. Lastly, another line extended from the receiving relay chain 228 to the telegrad 300 in Fig. 3 indicates control exercised over the telegrad.

From the speech path and the control tone path entering the receiving detector there are taken off two leads going to a control tone detector 249 and a speech current detector 250 which operate relays 251 and 252, respectively. These relays control a circuit from a source of adjusting tone 253 to the hybrid coil 222. This adjusting tone, like the control tone, lies just outside the voice frequency channel and is different from the control tone coming from the oscillator 240. It should be noted that by the use of appropriate filtering means an adjusting tone may be used which lies within the voice frequency channel since with narrow band filters the impairment of speech through the employment of such means is not important. If the relay 252 is operated and relay 251 is unoperated, then adjusting tone from the source 253 will be connected to the hybrid coil 222 and, therefore, transmitted to the distant end.

This condition may arise when fading or other manifestations of the mutable link become pronounced enough to allow the control tone relay 251 to release while speech is present. It has been found in practice that the release of relay 251 during the talking period reliably reports the fact that insufficient delay is present at the transmitting end. Therefore, if during normal operation when relay 252 is operated relay 251 releases, the adjusting tone 253 will be transmitted to the distant end.

At the distant end this adjusting tone will be transmitted from the hybrid coil 229 to the adjusting tone filter 254 and thence through the adjusting tone detector 255 to operate a relay associated with the variable delay 215 to cause an automatic adjustment of this delay to be made.

The variable delay control may be readily understood by the use of Fig. 4. In this case the speech path is from the hybrid coil 212 into the variable delay 215 at the broken line X—X. Here the speech path enters a filter 400 and thence through the armature and contacts of relays 401, 402, 403, and other relays of a similar nature, to relay 404, inclusive. The speech path then passes out of this figure and into the repeater 216. Each relay 401, for instance, controls a voice delay network such as 405, 406, 407 and 408. Each of these delay networks in series provides an increasing amount of delay. Thus the network 405 may provide a delay of 4 milliseconds, the delay network 406 may provide a delay of 8 milliseconds, and lastly, the delay network 408 may provide a delay of 40 milliseconds. With a sufficient number of relays such as 401 to 404, inclusive, and a number of networks such as 405 to 408, inclusive, the delay in the voice currents may be changed from a minimum amount of 4 milliseconds to a maximum of 40 milliseconds, in steps of 4 milliseconds.

As an alternative arrangement each delay circuit such as 405 to 408 may be of the same value, 4 milliseconds. Then an extra contact on relay 402 may be provided to cause the operation of relay 401 so that as the brush 414 advances not only the relay to which it points but also all other relays beyond which it has passed will be operated so that the several delays will be added in series. Thus when relay 404 becomes operated all other relays will be operated and all the delay circuits will be included.

Other circuit arrangements may be provided and any suitable arrangement may be employed whereby as the brush 414 advances in a clockwise direction more and more delay is introduced in the speech circuit.

The relays 401 to 404, inclusive, normally connect an H-type network to the circuit in place of the delay networks such as 405. Thus the H-type network consisting of resistances 409 to 413, inclusive, substitutes for the delay network 405. When relay 401 is operated the network is disconnected from the speech channel and the delay 405 is introduced in its place.

The relays 401 to 404, inclusive, are operated by a switch arm 414 operated by a motor 415. When adjusting tone is transmitted from the distant end as an indication that the voice delay in this circuit is insufficient, then relay 416 will be operated. When relay 416 moves its armature it extends ground through the winding of a thermal or similar suitable slow operating relay 417 to a coil of the motor 415 which will cause the motor to move in a forward direction, that is, the brush 414 will be moved in a clockwise direction. When this happens a larger amount of delay will be automatically introduced into the voice transmitting path. The current flowing through the winding of the thermal relay 417 will cause a circuit to be established, through the action of this relay, to the backward winding of motor 415 to move the brush 414 in a counter-clockwise direction to reduce the delay introduced into the speech circuit. Since the relay 417 is slow in operating, if relay 416 operates sufficiently long then the brush 414 will be moved forward. The tendency then will be for the delay to require reduction, as it is desirable to keep the delay at as low a point as possible. If the reduction in delay caused by the slow releasing characteristic of the relay 417 becomes too large, then the relay 416 will again be operated to cause another forward movement of the motor 415. The action of this motor, therefore, is somewhat in the nature of a hunting operation, though if no clipping of speech as detected by this system occurs at the distant end the motor 415 will remain unoperated for correspondingly long periods of time.

As shown, the brush 414 operates relay 404 on its last step to introduce the maximum delay. If the brush 414 is driven to this point and maintained there for an appreciable time it may indicate trouble of a serious nature which will require the immediate attention of an attendant. Therefore a slow operating relay 420 is connected in parallel with relay 404, the slow operating characteristics of which may be adjusted to any desired value by means well known in the art. When relay 420 operates it closes a circuit for alarm 421.

In addition a conductor 422 may be used in

parallel with the alarm 421 or may be used instead of the alarm 421 and may operate a relay which will automatically send an alarm signal to the distant terminal. This may be done by means similar to the circuit controlled by relays 251 and 252 with proper receiving means such as the filter 254, the detector 255 and the relay 416 at the distant end. The conductor 422 may also lead to relay means which will operate in a similar manner to relay 138 to cause a special character code to be transmitted to the distant end and particularly as described in the copending application of Hall and Melhose, Serial No. 354,990, filed August 3, 1940.

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 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 trans-

mitting 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 periodic transition between a spacing and a marking impulse for the purpose of correcting the distributor speed at the distant end.

When the receiving chain is in its normal position 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. 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 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 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 auxilliary 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 transmission channel normally conditioned against the transmission of voice currents, voice current responsive switching means for changing said normal condition, voice current delay circuits for retarding the transmission of voice currents for allowing said switching means to operate prior to the arrival of voice currents at the distant end of said channel and automatic means for adjusting said voice current delay circuits.

2. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an adjustable voice current delay circuit arrangement and automatic means for adjusting said arrangement.

3. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an adjustable voice current delay circuit arrangement, and automatic means responsive to clipping of speech for adjusting said arrangement.

4. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an adjustable voice current delay circuit arrangement, means for automatically and continuously adjusting said arrangement to a minimum delay value and means responsive to clipping for interrupting said automatic and continuous operation and adjusting said arrangement to a higher delay value.

5. In a telephone system subject to clipping of speech due to tardy voice controlled switching, a transmission channel, an adjustable voice current delay circuit arrangement located at the transmitting end of said channel and means controlled from the distant receiving end of said channel for automatically adjusting said arrangement.

6. In a telephone system subject to clipping of speech due to tardy voice controlled switching a transmission channel, an adjustable voice current delay circuit arrangement located at the transmitting end of said channel, means for automatically and continuously adjusting said arrangement to a minimum voice delay value and means controlled from the distant receiving end of said channel for interrupting said automatic operation and adjusting said arrangement to a higher voice delay value.

7. In a communication system, a transmission channel normally conditioned against voice current transmission, voice current responsive means at the transmitting end of said channel for changing said normal condition thereat and for applying to said channel a source of control tone, means at the receiving end of said channel responsive to control tone for changing said normal condition thereat, an adjustable voice current delay circuit arrangement at the transmitting end of said channel for delaying the transmission of voice currents over said channel for a period sufficient to allow the completion of switching operations at the receiving end of said channel under control of said control tone, motor driven means at the transmitting end of said channel for automatically and continuously adjusting said arrangement to a minimum voice current delay value, a detecting circuit at the receiving end of said channel responsive to tardy switching under control of said control tone for transmitting to the said transmitting end of said channel a different control tone and means at said transmitting end of said channel responsive to said different control tone for interrupting said automatic and continuous adjusting operation and adjusting said voice current delay circuit arrangement to a higher voice current delay value.

8. In a communication system, a transmission channel normally conditioned against voice current transmission, voice current responsive means at the transmitting end of said channel for switching said channel thereat into condition for the transmission of voice currents and for applying to said channel a source of control tone, means at the receiving end of said channel responsive to control tone for switching said channel thereat into condition for the transmission of voice currents, an adjustable voice current delay circuit arrangement at the transmitting end of said channel for delaying the transmission of voice currents over said channel for a period sufficient to allow said switching operation at the receiving end of said channel to reach completion, motor driven means at the transmitting end of said channel for automatically and continuously adjusting said arrangement to a minimum voice current delay value, a detecting circuit at the receiving end of said channel responsive to tardy switching under control of said control current and to severe attenuation of said control current after said switching operation thereat has reached completion for transmitting to the said transmitting end of said channel current from a different source of control tone, and means at said transmitting end of said transmission channel responsive to said different control tone for interrupting said automatic and continuous adjusting operation and adjusting said voice current delay circuit arrangement to a higher voice current delay value.

9. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an adjustable voice current delay circuit arrangement, automatic means for adjusting said arrangement, slow acting means responsive to a prolonged extreme adjustment of said arrangement and an alarm circuit operated by said slow acting means.

10. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, voice current responsive switching means for changing said normal condition, voice current delay circuits for retarding the transmission of voice currents for allowing said switching means to operate prior to the arrival of voice currents at the distant end of said channel, and means operable in accordance with a condition of the transmission

channel for adjusting said voice current delay circuits.

11. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, voice current responsive switching means for changing said normal condition, voice current delay circuits for retarding the transmission of voice currents for allowing said switching means to operate prior to the arrival of voice currents at the distant end of said channel, and delay modifying means operable under the control of insufficiently early operation of the switching means.

12. In a telephone system subject to clipping of speech due to delay of voice controlled switching, an adjustable voice current delay circuit arrangement, and automatic means operable under the control of apparatus conditioned conjointly by voice waves and switching apparatus for adjusting the voice current delay circuit arrangement with respect to its delaying characteristics.

13. In a system for transmitting signal waves accompanied by convoy waves, an adjustable signal wave delay circuit arrangement at the transmitting end, automatic means operable under conjoint control of the convoy waves and signal waves for adjusting the delay characteristics of said arrangement.

14. In a telephone system subject to clipping of speech due to tardy voice control switching, an adjustable voice current delay circuit arrangement at the transmitting terminal of said system, and automatic means including means controlled by a condition incidental to clipping of speech at the receiving end of said system for adjusting said arrangement.

15. The method of operating a signal transmission system which comprises transmitting signal wave energy and control wave energy in a variable time relationship, receiving control energy originating at a remote point at the transmission point, and automatically controlling the relationship by the control energy.

16. The method of receiving a signal wave accompanied by a control wave in a variable relationship which comprises conjointly utilizing the signal wave energy and the control wave energy to control the transmission in a medium extending in the direction of the arriving signal wave energy of regulating energy which is a function of the relationship existing at a given time.

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