Nov. 3, 1942. A. E. MELHOSE 2,300,798

VARIABLE VOICE DELAY NETWORK CONTROL

Filed Aug. 31, 1940 4 Sheets-Sheet 1

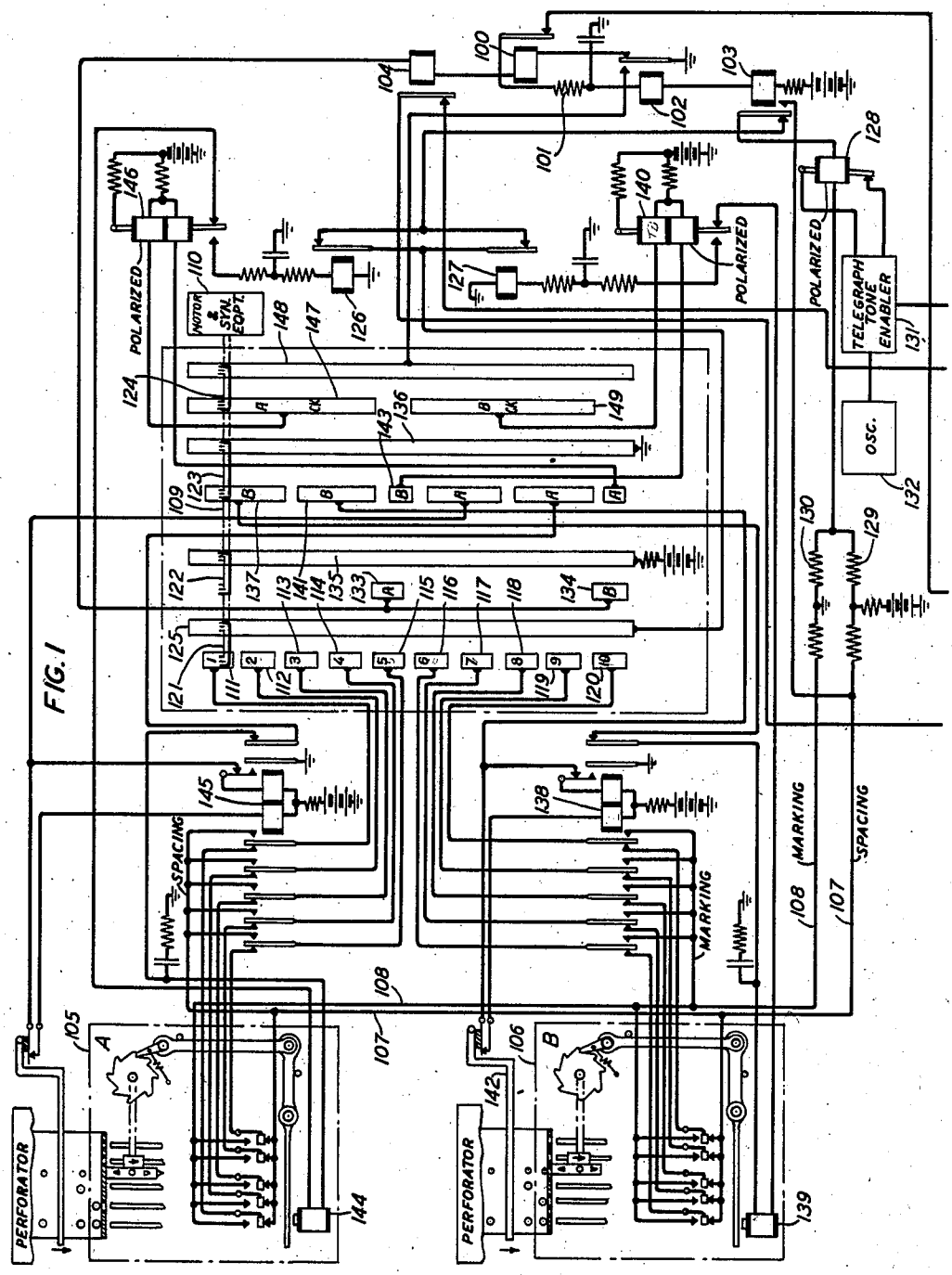

FIG. 1

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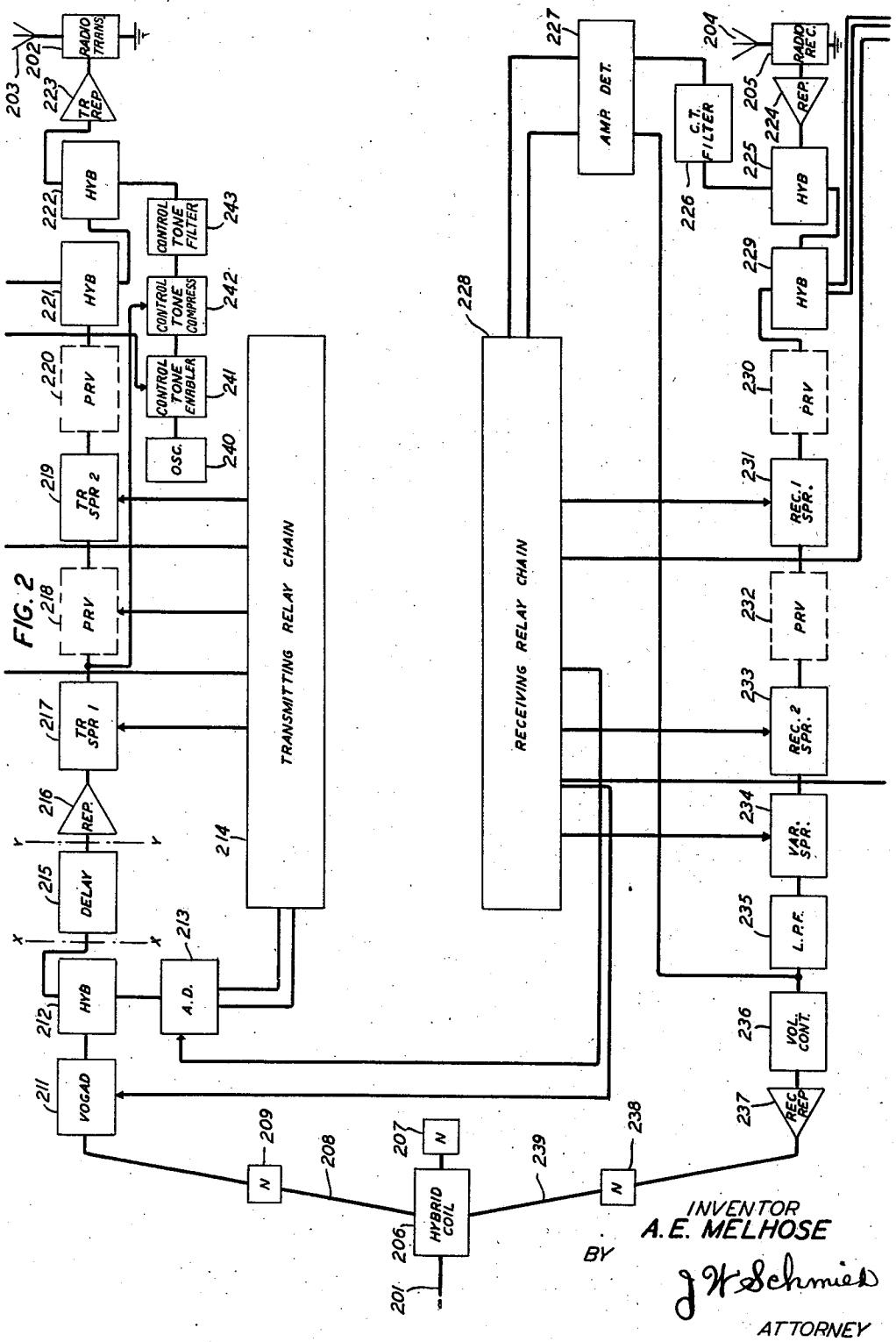

FIG. 2

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VARIABLE VOICE DELAY NETWORK CONTROL

Filed Aug. 31, 1940 4 Sheets-Sheet 3

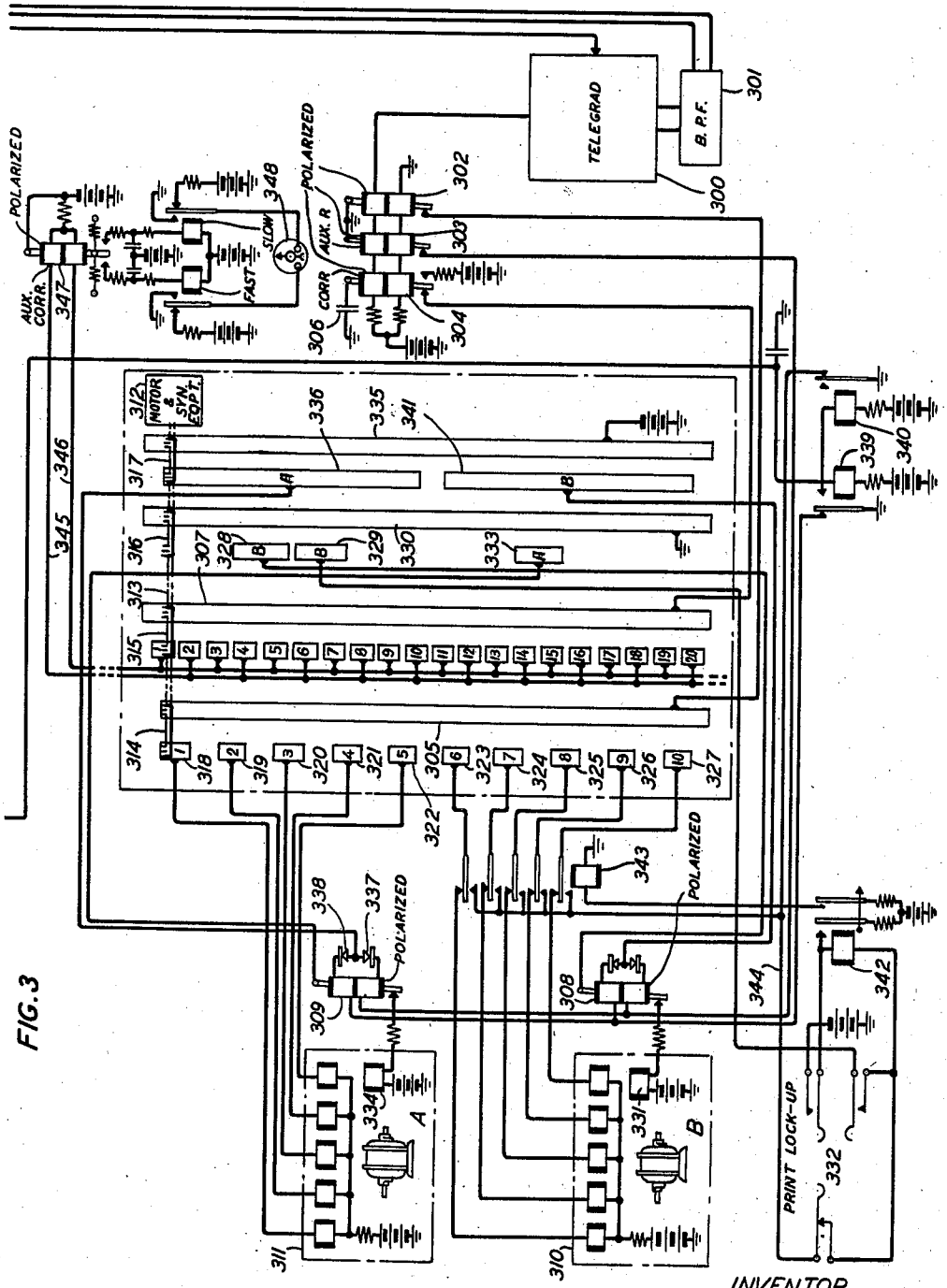

FIG. 3

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VARIABLE VOICE DELAY NETWORK CONTROL

Filed Aug. 31, 1940 4 Sheets-Sheet 4

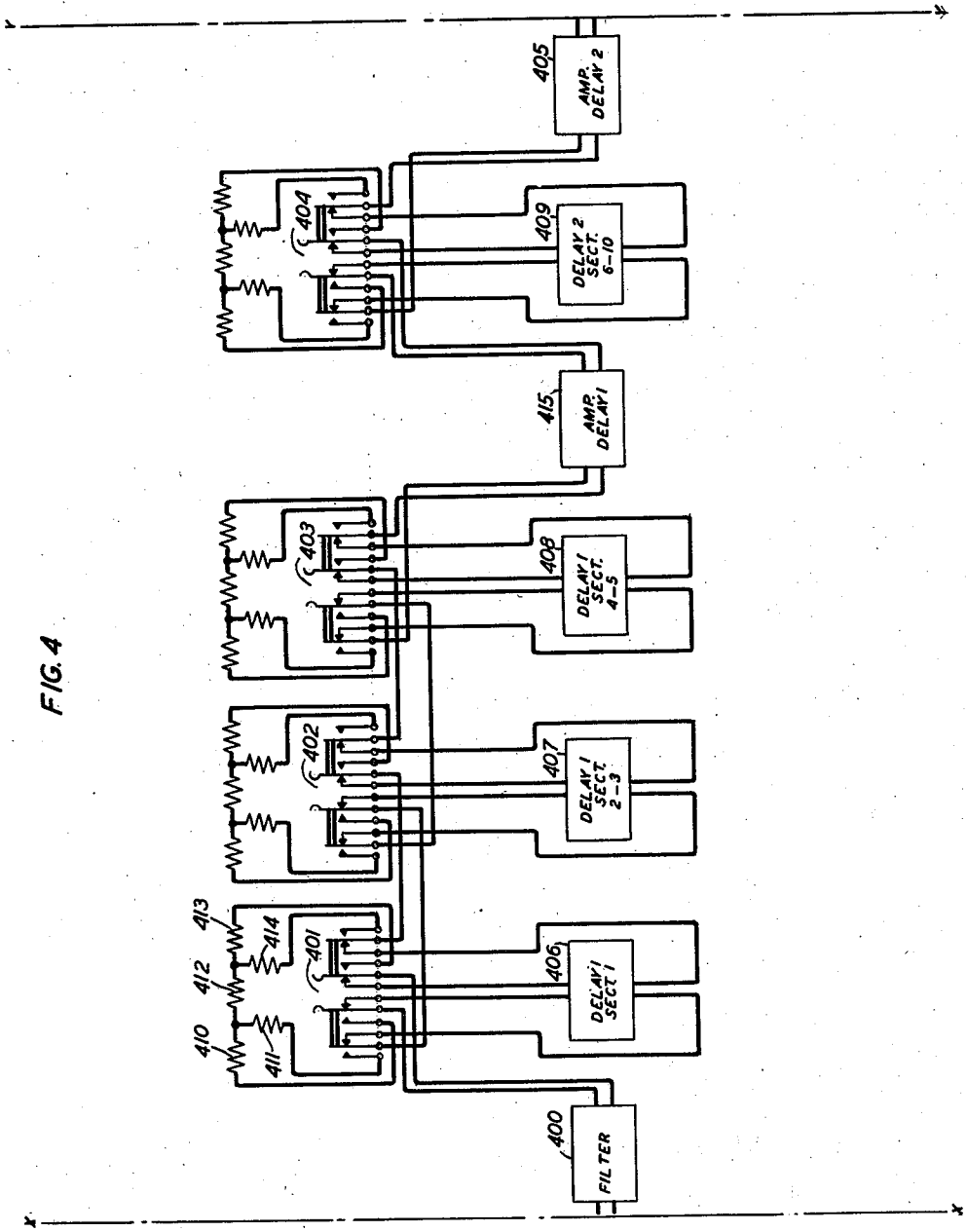

FIG. 4

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Patented Nov. 3, 1942 2,300,798

UNITED STATES PATENT OFFICE

2,300,798

VARIABLE VOICE DELAY NETWORK CONTROL

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Application August 31, 1940, Serial No. 354,988

6 Claims. (Cl. 179—4)

This invention relates to communication systems and particularly to long line telephone systems where voice operated switching devices are used.

In such systems where the communication channel is normally conditioned against transmission of voice currents the incoming voice currents must be made to cause a switching action to take place so as to place the communication channel in the proper condition. Therefore, it is usual to insert a voice delay circuit or network in the voice path to give sufficient opportunity for the switching to take place. If too little delay is provided, then the switching does not occur soon enough and a small part of the syllable or perhaps a whole syllable of the speech which has set the switching devices into operation is lost or "clipped." Clipping is thus directly traceable to insufficient delay.

On the other hand, if too much delay is introduced the naturalness of a telephone conversation suffers since the listener cannot get an immediate response to his remarks. This effect is, of course, aggravated by the so-called hangover time in the release of the talking circuit in the opposite direction. It is, therefore, desirable to use a minimum of delay.

Other factors which affect the amount of speech delay used are the action of mutable links such as fading on transoceanic radio telephone circuits and the talking habits or speech characteristics of different users of this type of apparatus. It is therefore usual to place sufficient delay in this type circuit to give good service under the poorest conditions.

The object of the present invention is to improve operating conditions by decreasing the amount of delay in the speech path to a minimum and to have means for rapidly increasing this amount when "clipping" is noted. Therefore, a plurality of delay circuits or networks are provided and these are controlled by switching means so that the amount of delay may be varied at will. By way of example, the delay may be varied within a range of zero to approximately 40 milliseconds in steps of 4 milliseconds each. The operating routine then is for the technical operator who is responsible for the continuous proper functioning of the apparatus to set the delay at a minimum value. When a distant operator or monitoring operator notes clipping taking place, a report is made to the technical operator, who thereupon makes an adjustment in the delay circuits. According to routine the technical operator will reduce the amount of delay to the minimum or to the point where a minimum number of reports of clipping are received.

A feature of the invention is an adjustable voice current time delay circuit whereby the marginal time operation of the switching circuits at the receiving end of a transmission channel may be maintained at a minimum point over a period including varying conditions tending to disturb such marginal time operation.

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

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 diagrams, shows the telephone and controlling circuits;

Fig. 3 shows the receiving telegraph circuits; and

Fig. 4 is a detailed circuit diagram 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 XX and YY.

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

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

In general, speech over channel 201 enters the hybrid coil 206 provided with the usual balancing network 207, passes over path 208 through the network 209 to the voice operated gain adjusting device (termed vogad for short) 211. From the vogad 211 speech currents enter the hybrid coil 212 where they split, part going on to the main speech channel and part entering the syllabic amplifier-detector 213 for control purposes. The output of the amplifier-detector 213 feeds into the transmitting 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 relay chain 214 clears the way for the speech currents to the antenna 203 and that the reception of this transmission at 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 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 transmitter 202.

At the distant receiving end the speech currents transmitted from the radio receiver 205 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, 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 path 239 beyond the repeater 237 by the unidirectional characteristics of this repeater. The function of the balancing network 207 is well known. In this connection it should also be noted that each of the hybrid coils 212, 221, 222, 225 and 229 is provided with an appropriate balancing network. The networks 209 and 238 are provided to perform certain functions necessary in commercial telephone circuits to compensate for the differences in transmission when the channel 201 is connected to different types of telephone circuits. Their inclusion or noninclusion in the system is immaterial to the functioning of the apparatus comprising the present invention but they are included in the schematic part of this disclosure 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 reasonably 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 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. The two privacy system units 218 and 220 are included to render the speech between the antenna 203 and the distant antenna 204 unintelligible, but do not form any essential part of the present invention, being 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. 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 relay 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 relay 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 in inverse proportion to speech current volume.

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, 223 and 237, 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 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 relay 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 relay 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 unpleasant operations of the circuit will not disturb the listeners. 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. 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 the proper operation of the receiving master relay within the receiving relay chain 228. By the time that the voice arrives, the receiving chain will have conditioned the receiving circuit, particularly by operating the first and second receiving suppressors 231 and 233 and the variable suppressor 234. As the control tone is reduced in volume through the action of the control tone compressor 242, 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 causes the receiving 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 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 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 transmitting relay 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 connection extending to the syllabic amplifier-detector 213 indicates that the receiving relay chain operates to disable the amplifier-detector 213. A similar connection extended to the vogad 211 indicates control of the vogad by the receiving relay chain. Lastly, another connection extended from the relay chain 228 to the telegrad 300 in Fig. 3 indicates control exercised over the telegrad by the receiving relay chain.

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 where-

by 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 and antenna 203.

It should be noted that when the transmitting relay chain 214 is operated and, consequently, relay 103 is operated, that a connection is extended from spacing battery lead 107 through the front contact and armature of relay 103 to the winding of relay 128 to hold this relay spacing and, therefore, continuously to block the transmission of telegraph tone 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 relay 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 or 134, 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 makes before break or continuity contact 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 is 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 relay chain 228 is in its normal unoperated condition then the telegrad 300 will be enabled. This will render the telegrad effective to operate the receiving telegraph apparatus. At this time telegraph signals being received by the radio receiver are passed into hybrid coil 229 and thence into the band-pass filter 301 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 keys 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 relay 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 telegraph 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 printer 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 relay 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 relay chain 228.

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

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

The delay circuit 215 forming the principal feature of the present invention is shown in more detail in Fig. 4 which may be inserted in the general schematic diagram at the lines XX and YY in Fig. 2. The path from the hybrid coil 212 enters a filter 400 and from there passes through the contacts of keys 401, 402, 403 and 404 to an amplifier 405 before entering the repeater 216. Associated with each key is a delay circuit network. Delay circuit 406 is associated with key 401, delay 407 is associated with key 402, delay circuit 408 is associated with key 403 and delay circuit 409 is associated with key 404. With the keys in their normal position as shown all of the delay circuits are included in the speech path. These delays are of various natures. That is,

delay 406 will cause speech currents to be delayed for 4 milliseconds, delay 407 will cause speech currents to be delayed 8 milliseconds, delay 408 will cause speech currents to be delayed 8 milliseconds and delay 409 will cause speech currents to be delayed 21 milliseconds. Thus with the keys 401 to 404 as shown a total of 41 milliseconds delay will be introduced into speech currents flowing through this circuit. By the operation of these keys in various combinations the delay may be varied from a value of 0 to the total value of 41 milliseconds in steps of about 4 milliseconds each. Thus if key 401 alone is in the position shown a speech delay of 4 milliseconds will occur. If key 402 alone is in the position shown a speech delay of 8 milliseconds will be involved. If keys 401 and 402 are as shown and keys 403 and 404 are operated, then a delay of 12 milliseconds will be provided for. Other combinations of these keys will be apparent.

When the key 401, for instance, is operated then a compensating H-type network comprising the resistances 410 to 414, inclusive, will be introduced in the circuit in place of the delay network 406. An amplifier 415 may be included in the circuit between the first three delay circuits 406 to 408, inclusive, and the last delay circuit 409.

These keys 401 to 404, inclusive, are to be operated by a technical operator at this terminal. Similar arrangements at the other distant terminal are provided. The operation in general is to reduce the delay to a minimum amount. When clipping of speech is noted at one terminal, and this occurs frequently enough to be objectionable, the technical operator at the distant terminal is notified and he thereupon operates the keys 401 to 404 to include sufficient delay to overcome the difficulty. It has been standard practice heretofore to provide sufficient delay to provide good operation of the circuits under the most severe conditions which could be expected but this penalizes the circuit under favorable conditions and hence, the variable delay is now provided and the method of operation established whereby the delay is reduced to minimum until clipping at the distant end occurs.

What is claimed is:

1. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, voice operated switching means for conditioning said channel for the transmission of voice currents, a source of alternating current for transmission over said channel together with speech current under control of said switching means, and an adjustable delay circuit in the speech path for delaying the voice currents whereby the relative times of the arrival of the said alternating current and the said voice currents at the distant end of said transmission channel may be controlled.

2. In a communication system, a transmission channel, said channel including as a portion thereof and at the transmitting end thereof a split circuit, means in one branch of said split circuit responsive to voice currents for transmitting control tone comprising current from a source of alternating current to the distant end of said channel, and adjustable means in the other branch of said split circuit for controlling the relative times of the arrival at the distant end of said channel of said control tone and voice current.

3. In a communication system, a transmission channel, said channel including as a portion thereof and at the transmitting end thereof a split circuit, said channel including as a portion thereof and at the receiving end thereof a split circuit, a source of control tone, means in one branch of said transmitting split circuit responsive to voice currents for connecting said source of control tone for transmission of control tone over said transmission channel, means in one branch of said receiving split circuit for blocking transmission from said channel beyond that point, means in the other branch of said receiving split circuit responsive to control tone for operating said blocking means to allow voice currents to freely pass said point and adjustable means in the other said branch of said transmitting split circuit for delaying the transmission over said channel until said control tone has been connected for transmission over said channel and said blocking means has been operated thereby.

4. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, voice operated switching means for conditioning said channel for the transmission of voice currents, a source of alternating current for transmission over said channel with speech under control of said switching means, delay circuits in the speech path for delaying the voice currents for controlling the relative times of the arrival of the said alternating current and the said voice currents at the distant end of said transmission channel and means for varying the number of said delay circuits included in said speech path.

5. In a communication system wherein telegraph signals are interpolated in telephone conversations during lulls and pauses therein, telegraph and telephone circuits at the transmitting and receiving terminals of the said system, a transmission channel extending from each transmitting terminal to each distant receiving terminal, switching means for alternatively connecting said telegraph and said telephone circuits to said channels, each said channel being normally switched for the transmission of telegraph signals, voice operated means at the transmitting end of each said channel for operating the said switching means thereat and for connecting a source of control current to the said channel, means at the receiving end of each of the said channels responsive to control current for operating the said switching means thereat, voice current delay circuits at the transmitting end of each said channel for delaying the transmission of voice currents over the said channels for a predetermined period after said control current has been connected thereto and means for varying the length of said predetermined period.

6. A transmission path including a switching device having two alternative positions, a delay circuit of substantial electrical delay characteristics and a compensating network having impedance characteristics equivalent to those of the delay circuit and of relatively negligible delay characteristics in combination with contacts on the switching device alternatively in two positions thereof for connecting the delay circuit or the compensating network into the transmission path.

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