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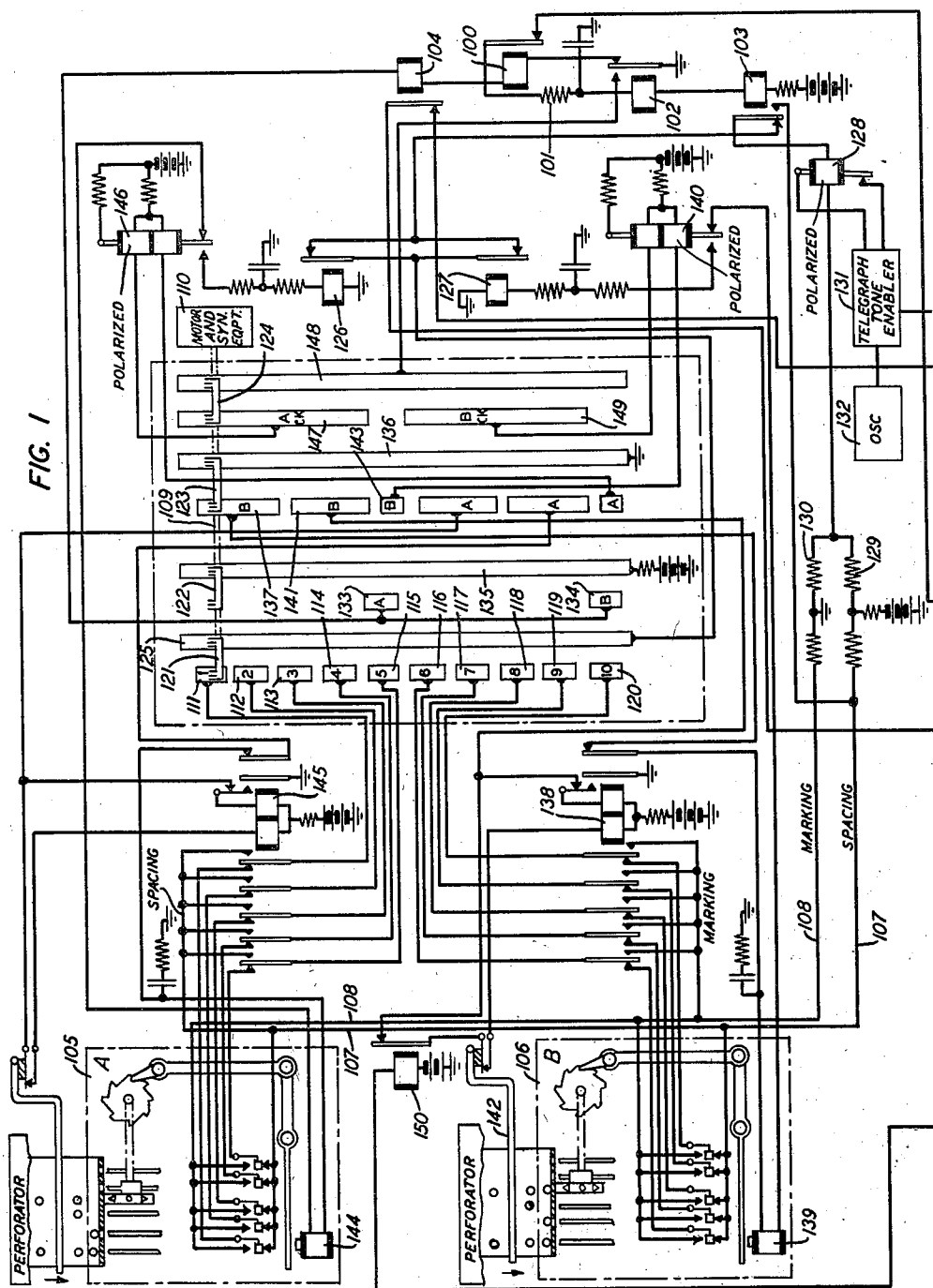
J. A. HALL ET AL

2,283,203

SEMI-AUTOMATIC CONTROL SYSTEM

Filed Aug. 31, 1940

3 Sheets-Sheet 1



INVENTORS J. A. HALL
A. E. MELHOSE
BY *J. H. Schmitt*
ATTORNEY

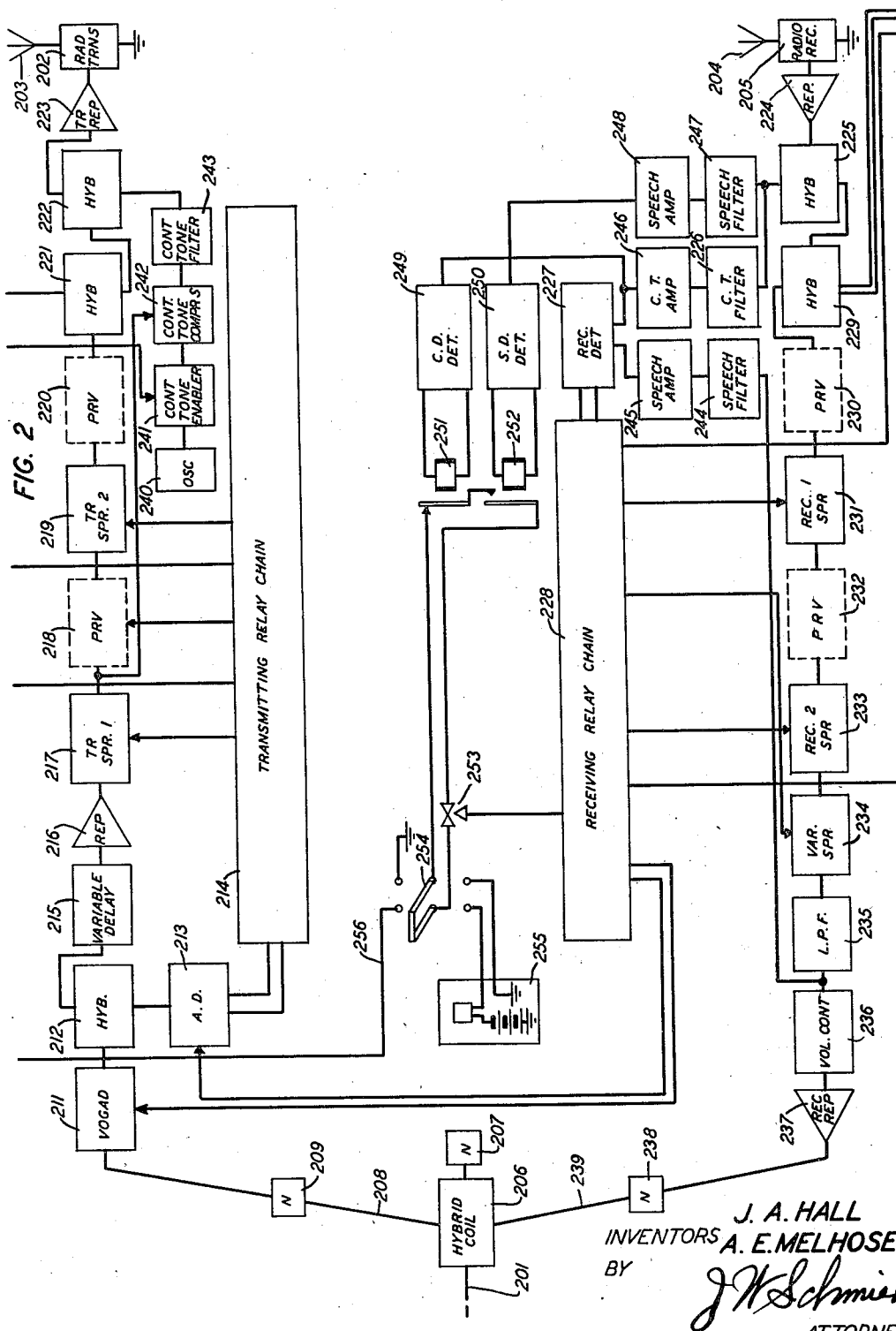
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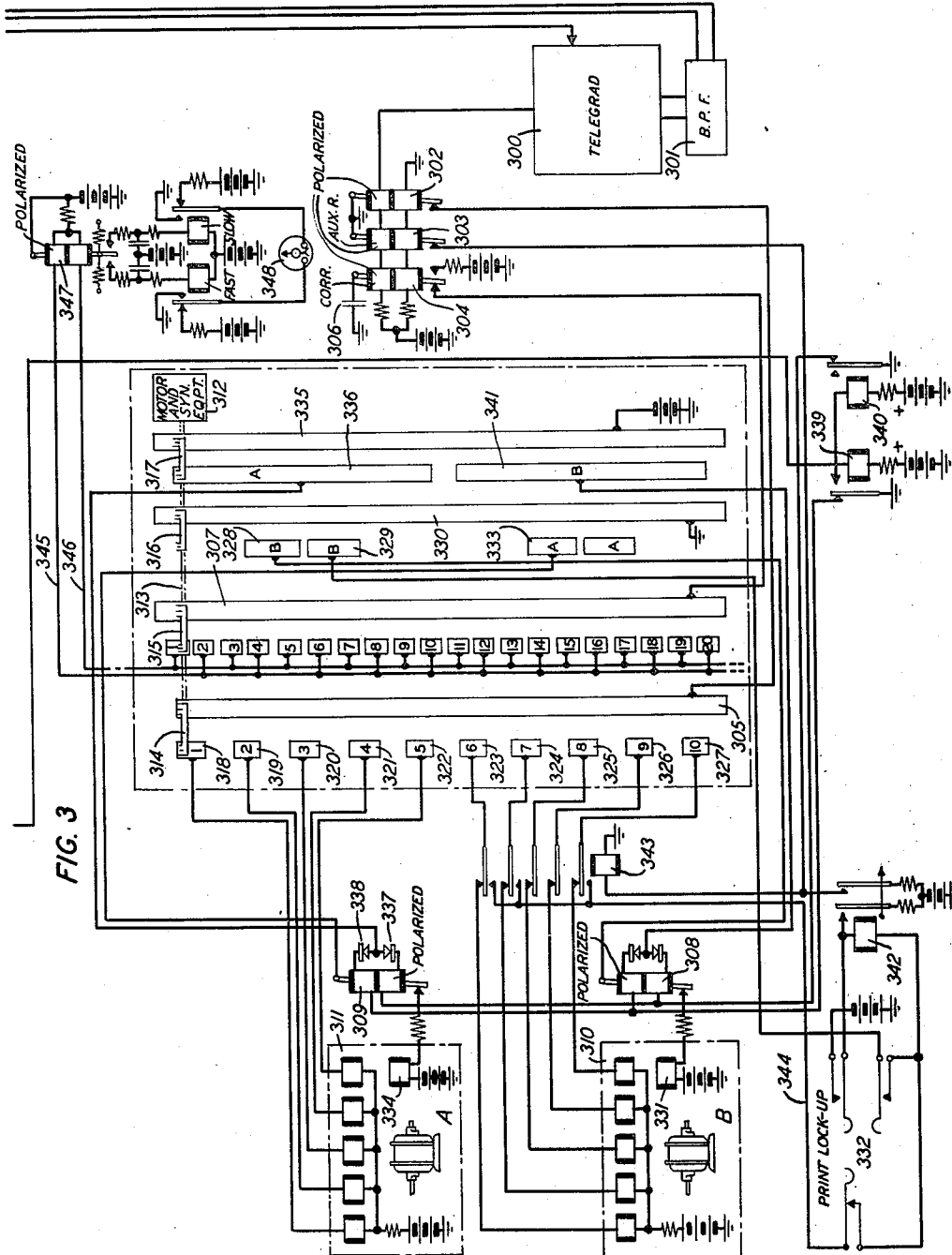
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INVENTORS J. A. HALL
A. E. MELHOSE
BY *J. W. Schmed*
ATTORNEY

UNITED STATES PATENT OFFICE

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SEMI-AUTOMATIC CONTROL SYSTEM

John A. Hall, Summit, and Alfred E. Melhose,
Westfield, N. J., assignors to Bell Telephone
Laboratories, Incorporated, New York, N. Y., a
corporation of New York

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

In telephone systems wherein a transmission channel must at certain times be conditioned against speech transmission voice controlled switching means are provided to condition such channel for speech transmission. The control is gained at the transmitting end and must be exercised at the receiving end. In order that the switching may be completed at the receiving end promptly so as not to mutilate the speech by clipping of the forward ends of syllables, delay circuits or networks are introduced in the speech path to allow time for the switching operations at the receiving end to take place.

Various factors enter into the causes of tardy switching operations, the chief one among these causes being the action of a mutable link, the manifestation being the fading or diminution of signals. In systems employing control tone transmitted with speech selective fading often diminishes the control tone below a useful point whereupon the switching operation cannot be completed in time to allow the free passage of all the speech currents and the phenomenon known as clipping results. Another factor is the different speaking habits of different persons, it being known that a small percentage of telephone users enunciate their syllables in such a way that the starting of their speech is done with little energy.

Under normal conditions the delay introduced in the speech channel for this purpose of preventing clipping may be held at a minimum amount to achieve the greatest naturalness in a telephone conversation, but there are times when this amount must be increased. Heretofore the amount of delay was fixed and dictated by experience and based on the most adverse conditions likely to be encountered.

The object of the present invention is to improve such communication systems by making this voice current delay adjustable so that it can be held at a minimum amount until adverse conditions are encountered and then adjusted to meet such adverse conditions.

A feature of the present invention is an alarm circuit responsive to clipping comprising a normally open point and a normally closed point and means responsive to normal operation for opening such normally closed point prior to the closure of such normally open point. In accordance with this feature, the normally open point is

controlled by voice currents as received at the receiving end of the transmission channel and the normally closed point is controlled by the means for causing the initial switching operation thereat. Therefore if the normally closed point in the alarm circuit is opened before the normally open point is closed the indication is that the switching has taken place properly before the arrival of the voice currents and no syllables will be clipped. On the other hand if the normally open point is closed first so that the alarm circuit becomes completely closed, it is an indication that the voice currents have arrived before the switching could have taken place and that consequently clipping has occurred.

Another feature is a second normally closed point in the alarm circuit which is normally the last of these points to be operated. This point is controlled by the actual switching operation. Such a feature is particularly useful where control tone with speech is employed and where such control tone is subject to selective fading. In the preferred specific embodiment of the present invention it is arranged that when the control tone is first applied to the transmission channel it is applied at a high level but such level is thereafter reduced when the delayed voice currents come on to the channel. Since at the receiving end the voice currents are employed to maintain the switched circuits after the control tone has initially caused the switching to take place, the control tone may at times fall below the level to maintain the said switched condition without the aid of the voice currents. If at such times the normally closed point in the alarm circuit were to be reclosed then without this third and normally closed point being provided a false indication might be given.

Another feature of this invention is a means to relay an alarm to the transmitting end of the transmission channel so that an adjustment can be made in the time delay circuits to obviate the difficulty which has led to the condition which has caused the alarm indication to be given.

Still another feature is a means for automatically telegraphing an alarm indication of an unstandard condition in a telephone circuit.

These and other features will be more fully pointed out in the following description and the appended drawings.

The drawings consist of three 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; and

Fig. 3 shows the receiving telegraph circuits.

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

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

In general, speech over channel 201 enters the hybrid coil 206 provided with the usual balancing network 207, passes over path 208, through the network 209, to the voice operated gain adjusting device (termed vogad for short) 211. From the vogad 211 speech currents enter the hybrid coil 212 where they split, part going on to the main speech channel and part entering the syllabic amplifier-detector 213 for control purposes. The output of the amplifier-detector 213 feeds into the transmitting 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 currents to the antenna 203 and that the distant receiving terminal similarly conditions the receiving circuits thereat for the proper reception of the speech currents. The main portion of the speech currents then passes from the hybrid coil 212 into the variable 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 through the control tone amplifier 246 to the receiving detector 227 which operates the receiving relay chain 228. This receiving 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 relay chain 214 to properly perform its functions before the voice currents are finally delivered for transmission over 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 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 regulate 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 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 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 special speech 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 relay 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 regulated 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 low value where the 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 relay 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.

The output of hybrid coil 225 feeds into a speech filter 247 in addition to the control tone filter 226. From the speech filter 247 the speech currents go through a speech amplifier 248 into a speech current detector 250. The output of the control tone amplifier 246 also works into a separate control tone detector 249 and these detectors 249 and 250 control relays 251 and 252, respectively. It may be noted that the two relays 251 and 252 may be replaced by a single relay with two windings working in opposition. In the normal operation of the system, control tone always precedes voice currents and hence relay 251 will always be operated before relay 252 is operated and hence the normally open circuit including the contacts and armatures of these two relays is kept open.

If for some reason, possibly the action of the mutable link, the control tone does not arrive at the receiving terminal in time to properly operate the receiving relay chain 228, then the speech path to the hybrid coil 206 will not be opened up in time, with the result that a syllable will be clipped off the speech.

Since this phenomenon known as clipping is a reliable indication of the lack of sufficient delay at the transmitting end, the present arrangement, which responds to clipping, is employed for giving an alarm. If the switch 254 is moved to its lower position an alarm 255 will be connected to the contacts and armatures of relays 251 and 252. Now if clipping occurs this phenomenon will operate the relays 252 and 251 in such a sequence that the alarm circuit 255 will be operated, that is, if speech arrives at the receiving terminal before the control tone, then relay 252 will be operated and the circuit to the alarm 255 will be closed.

An additional control, here designated by the numeral 253, is an arrangement under control of the receiving relay chain 228 for opening this alarm circuit. The function of this circuit controller is to prevent the operation of the alarm 255 after the speech channel to the final receiving circuit has been properly established. If under normal operation relay 251 first operates and opens the alarm circuit, then the receiving relay chain 228 operates and later the relay 252, responding to voice, operates; this series of operations will be the normal sequence, and the alarm circuit 255 will not be operated. Therefore, if, while the voice is properly being received over the radio receiver 205, and transmitted to the channel 201, the mutable link causes the

relay 251 to release, the alarm circuit 255 will not be operated. It has been found in practice that after the speech path has been properly established and the control tone compressor 242 at the distant transmitting end has been operated that control tone through the control tone filter 226 sometimes drops to a value where the receiving relay chain might otherwise be released. Under these conditions the relay 251 might be released. In the case of the receiving relay chain 228 speech augments the action of the control tone to hold the receiving chain 228 operated, but in the case of this alarm circuit the relay 251 might become released while relay 252 remains operated. Therefore, the control 253 is operated by the receiving relay chain 228.

When the alarm 225 operates, the technical operator will notify the technical operator at the distant transmitting terminal who will thereupon manipulate the variable delay circuit 215 to introduce more delay into the speech path at such distant terminal to overcome the difficulty.

An alternative arrangement is provided by the switch 254. If this is moved to its upper set of contacts then the action corresponding to the operation of the alarm 255 will be the operation of a relay 150. As will be more fully explained hereinafter, the operation of relay 150 will interrupt the action of the associated telegraph transmitter 106 and cause a particular signal to be repeatedly sent to the distant end. Through the use of this means, then, a semiautomatic operation is achieved, that is, in response to clipping at one terminal a particular code signal is sent over the telegraph circuits to the other terminal and the technical operator thereat, recognizing this code signal, will make an adjustment of the variable delay at such distant point to overcome the difficulty. This particular code which is sent over the telegraph channel may be looked upon as an alarm signal since it has this particular effect at that point.

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 contact and armature of relay 150, 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 mark-

ing pulses would have been repeatedly sent each time the brush 125 passed over the segments 116 to 120, inclusive.

As hereinbefore mentioned, if relay 150 is operated then relay 138 will become operated when the brush 123 passes over segment 141 and during the time that relay 138 is so operated a particular code consisting of five marking impulses will be sent to the distant end.

It should also be noted that relay 150 may also be caused to perform in the same manner as relay 138, that is, it may open up the connections to segments 116 to 120, inclusive, and connect these instead to the proper contacts of the tape transmitter circuit to particular combinations of spacing and marking battery so that any particular given character may be transmitted to the distant end as an alarm signal. In case relay 150 is so provided, it would have a means to open the stepping magnet 139 similar to the outer right-hand armature and contact of relay 138 so that the message being transmitted by this tape transmitter will not be mutilated.

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

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

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

It should be noted before leaving the description of the transmitting telegraph apparatus that if both the taut tape switches open the left-hand windings of relays 138 and 145, respectively, that the contacts and the left-hand armatures of relay 145 are connected to spacing battery so that first a series of five marking impulses and later a series of five spacing impulses will be transmitted. This provides for a periodic transition between a spacing and a marking signal 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 deceiver 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 auxiliary corrector relay 347 and therefore the discharge of the condenser 306 will tend to operate the relay 347 in one direction if the motor 312 is running fast or operate the relay 347 in the other direction if the motor 312 is running slow. The correcting means is well known and will not be further described except to note that a device 348, which will indicate fast or slow operation, is inserted at this point to indicate that correction may be properly made.

What is claimed is:

1. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for switching both the transmitting and receiving ends of said channel into condition for the transmission of voice currents, voice current

delay circuits for delaying the transmission of voice currents for a period sufficient to allow said switching operations to be completed before the arrival of said voice currents at the receiving end of said channel and means responsive to the arrival of said voice currents at the said receiving end of said channel prior to the completion of said switching operations for operating an alarm.

2. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for switching both the transmitting and receiving ends of said channel into condition for the transmission of voice currents, voice current delay circuits for delaying the transmission of voice currents for a period sufficient to allow said switching operations to be completed before the arrival of said voice currents at the receiving end of said channel and means at the receiving end of the said channel responsive to the arrival of said voice currents at the said receiving end of said channel prior to the completion of said switching operations for operating an alarm.

3. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for switching both the transmitting and receiving ends of said channel into condition for the transmission of voice currents, voice current delay circuits for delaying the transmission of voice currents for a period sufficient to allow said switching operations to be completed before the arrival of said voice currents at the receiving end of said channel and means at the receiving end of said channel responsive to the arrival of said voice currents at the said receiving end of said channel prior to the completion of said switching operations for operating an alarm at said transmitting end of said channel.

4. In a communication system, a transmission channel normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for enabling the transmitting end of said channel to transmit 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 enabling the receiving end of said channel to transmit voice currents, means at the transmitting end of said channel for delaying the transmission of voice currents over said transmission channel for a period sufficient to allow said control tone to enable the said receiving end of said transmission channel and means responsive to the failure of said control current to enable the said receiving end of said transmission channel prior to the arrival of said delayed voice currents to operate an alarm.

5. In a communication system, a transmission channel, voice operated means at the transmitting end of said channel for applying a source of alternating current to said channel for transmission to the distant receiving end of said channel, a receiving chain of relay means at the receiving end of the said channel for performing switching operations thereat, said receiving chain being responsive to the said alternating current and to voice currents received over said transmission channel, and an alarm circuit enabled by voice currents and disabled by said alternating current and by said receiving chain of relay means.

6. In a communication system, a transmission

channel, voice operated means at the transmitting end of said channel for applying a source of alternating current to said channel for transmission to the distant receiving end of said channel, a receiving chain of relay means at the receiving end of the said channel for performing switching operations thereat, said receiving chain being responsive to the said alternating current and to voice currents received over said transmission channel, an alarm circuit enabled by voice currents and disabled by said alternating current and by said receiving chain of relay means and means operated by said alarm circuit for automatically transmitting an alarm indication to the said transmitting end of said channel.

7. In a communication system wherein telegraph signals are interpolated in speech during lulls and pauses in speech, two opposite direction one-way transmission channels each similarly equipped, voice operated means at the transmitting end of each said channel for applying a source of alternating current to the said channel for transmission to the distant receiving end of the said channel, a receiving chain of relay means at the receiving end of the said channel for performing switching operations thereat, said receiving chain being normally primarily operated by said alternating current and secondarily maintained operated by said alternating current and said voice currents an alarm circuit enabled by voice currents and disabled by said alternating current and by said receiving chain of relay means and means operated by said alarm circuit for automatically transmitting a series of characteristic telegraph signals over the other said transmission channel as an alarm indication.

8. In a communication system, a transmission channel including a mutable link normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for enabling the transmitting end of said channel to transmit 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 enabling the receiving end of said channel to transmit voice currents, adjustable means at the transmitting end of said channel for delaying by different lengths of time the transmission of voice currents over said transmission channel to allow said control tone to enable the said receiving end of said transmission channel under varying conditions in said mutable link, and an alarm circuit responsive to a misadjustment of said voice current delay means.

9. In a communication system, a transmission channel including a mutable link normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for enabling the transmitting end of said channel to transmit 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 enabling the receiving end of said channel to transmit voice currents, adjustable means at the transmitting end of said channel for delaying by different lengths of time the transmission of voice currents over said transmission channel to allow said control tone to enable the said receiving end of said transmission channel under varying conditions in said mutable link, and an alarm circuit at the receiving end of said channel responsive to a misadjustment of said voice current delay means.

10. In a communication system, a transmission channel including a mutable link normally conditioned against the transmission of voice currents, means at the transmitting end of said channel responsive to voice currents for enabling the transmitting end of said channel to transmit 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 enabling the receiving end of said channel to transmit voice currents, adjustable means at the transmitting end of said channel for delaying by different lengths of time the transmission of voice currents over said transmission channel to allow said control tone to enable the said receiving end of said transmission channel under varying conditions in said mutable link, an alarm circuit responsive to a misadjustment of said voice current delay means and means responsive to said alarm circuit for transmitting an indication to the said receiving end of said transmission channel.

11. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an alarm circuit responsive to clipping comprising a circuit including a normally open point and a normally closed point and means for normally opening said closed point prior to the closure of said open point.

12. In a telephone system subject to clipping of speech due to tardy voice controlled switching, an alarm circuit responsive to clipping comprising a circuit including a normally open point and two normally closed points, means for normally opening one of said closed points prior to the closure of said open point and means for thereafter opening the other of said closed points to prevent the giving of a false alarm through a later reclosure of said one of said closed points.

13. In a communication system having means for transmitting speech intermittently from a station A to a station B, means for transmitting convoy current from station A to station B to perform a conditioning operation at station B preparatory to reception of speech, in combination with means operable by the arrival of speech at station B before the conditioning operation has been performed producing an alarm at station B, said alarm consisting of something other than the distortion or mutilation of the received speech.

14. In a communication system having means for transmitting speech intermittently from a station A to a station B, means for transmitting convoy current from station A to station B to perform a conditioning operation at station B preparatory to reception of speech, in combination with means operable by the arrival of speech at station B before the conditioning operation has been performed producing an alarm at station A when the speech waves arrive at station B too early with respect to completion of the conditioning operation at station B.

15. In a communication system comprising a channel for transmitting speech from station A and receiving it at station B intermittently, means for transmitting a convoy current from station A and receiving it at station B, in combination with means whereby said convoy current performs a conditioning operation at station B to prepare for the reception of speech whereby the arrival of speech at station B too early with respect to the conditioning operation produces an indication thereof at station A also in combination with means at station A for in-

creasing the lead of the convoy current with respect to the initial portion of any significant group of speech waves.

16. In a system having means for intermittently transmitting speech waves from station A and receiving them at station B, means for transmitting a convoy current from station A to station B to establish and maintain conditions at station B suitable for effective reception of speech during the time of desired reception thereof, in combination with means operable by arrival of speech at station B outside of such times to establish a condition at station B indicating the necessity of readjusting the time relation of the convoy current and speech current, said condition being a condition other than incidental mutilation or distortion of speech.

17. In a system having means for intermittently transmitting speech waves from station A and receiving them at station B, means for transmitting a convoy current from station A to station B to establish and maintain conditions at station B suitable for effective reception of speech during the time of desired reception thereof, in combination with means operable by arrival of speech at station B outside of such times to establish a condition at station A indicating the necessity of readjusting the time relation of the convoy current and speech current.

18. In a system for intermittently transmitting by modulated waves a certain type of signal from station A to station B, other means for transmitting from station A to station B a convoy current to perform a conditioning operation at station B to prepare and maintain station B conditioned for reception of said certain type of signal, in combination with means at station B actuated by arrival of said certain type of signal current at station B before said conditioning operation has been performed to indicate the necessity of adjusting at station A the relation between the convoy current and the said certain signaling current, said indication being something other than distortion of or mutilation of said certain type of signal as received at station B.

19. In a system for transmitting from station A to station B speech representing currents accompanied and preceded by convoy current to perform a conditioning operation at station B to prepare said station for reception of said speech representing currents, means actuated by arrival of speech representing currents at station B too early for the preparation thereof by said convoy current to establish a condition indicative thereof, and means for automatically telegraphically transmitting a signal indicating such condition back to station A.

20. In a system for intermittently transmitting speech from station A to station B and intermittently transmitting speech from station B to station A, means at each of stations A and B for transmitting a convoy current to condition receiving apparatus at the remote station for reception of speech, and means at each station actuated by arrival of speech too early with respect to the conditioning operation to produce an indication signifying such too early arrival, such indication being something other than and in addition to mutilation or distortion of speech.

21. In a system for transmitting speech intermittently from station A to station B, means for transmitting from station A a convoy current preliminary to each transmission of speech to prepare and condition station B for reception of speech, in combination with means at station

B for transmitting out therefrom an indication of reception of speech in improper time relation to the convoy current.

22. In a system for transmitting speech intermittently from station A to station B, means for transmitting from station A a convoy current preliminary to each transmission of speech to prepare and condition station B for reception

of speech, in combination with means including telegraphic apparatus and a channel of telegraphic transmission for transmitting out therefrom an indication of reception of speech in improper time relation to the convoy current.

JOHN A. HALL.
ALFRED E. MELHOSE.