May 25, 1948. G. A. LOCKE 2,442,301

SYNCHRONIZING MECHANISM FOR TELEGRAPH SYSTEMS

Filed Feb. 21, 1944 3 Sheets-Sheet 1

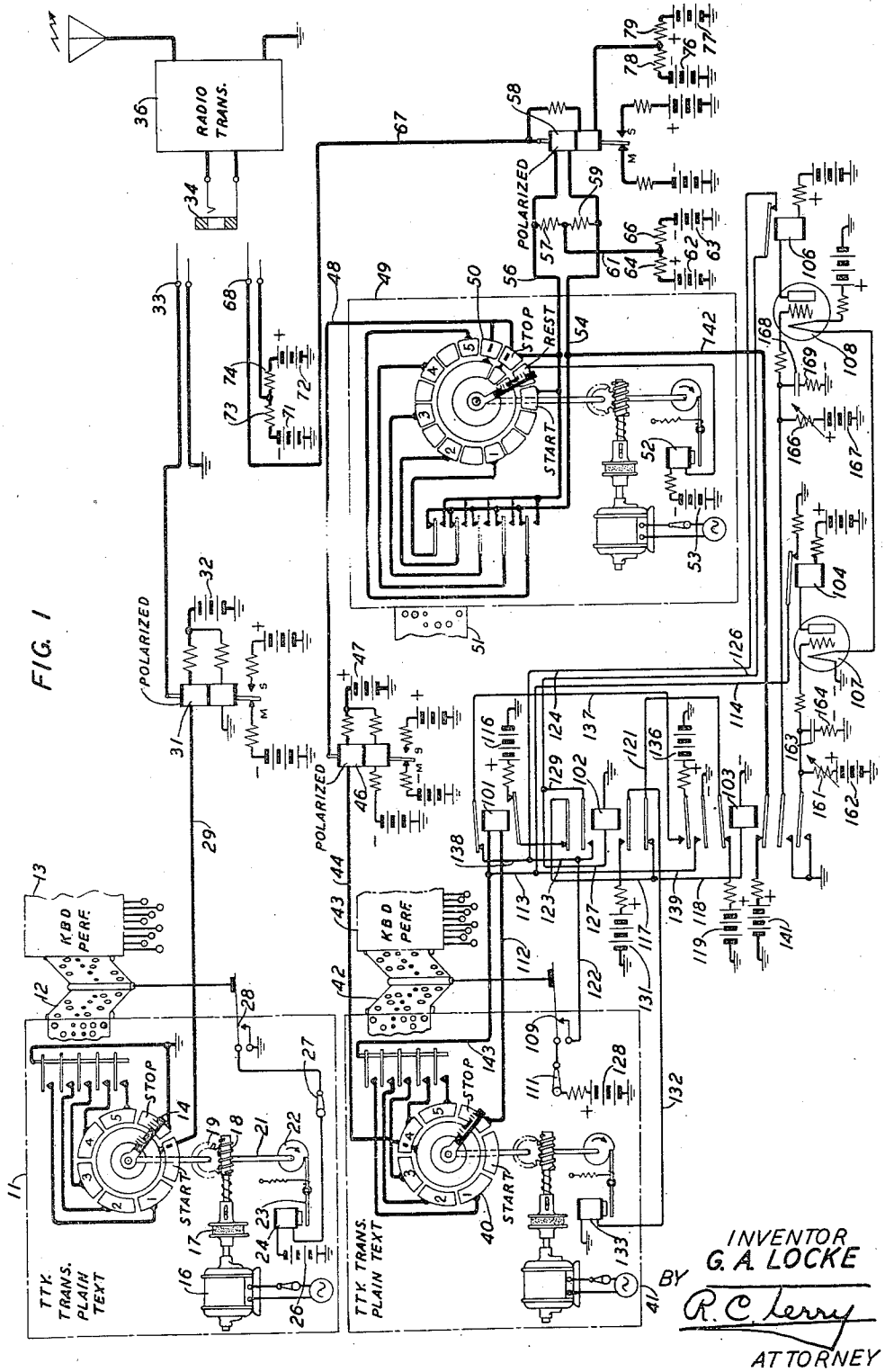


FIG. 1

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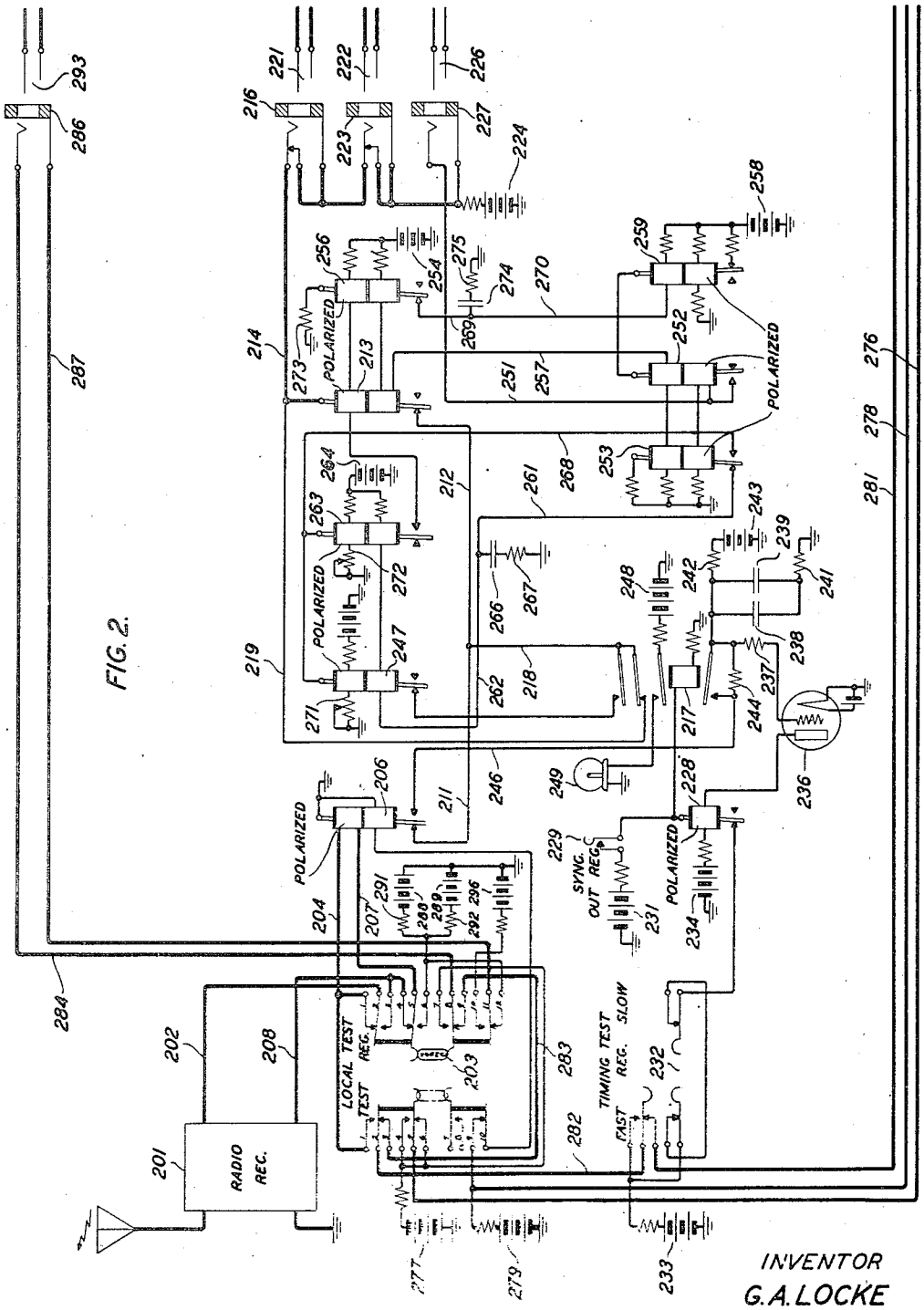


FIG. 2.

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Filed Feb. 21, 1944 3 Sheets-Sheet 3

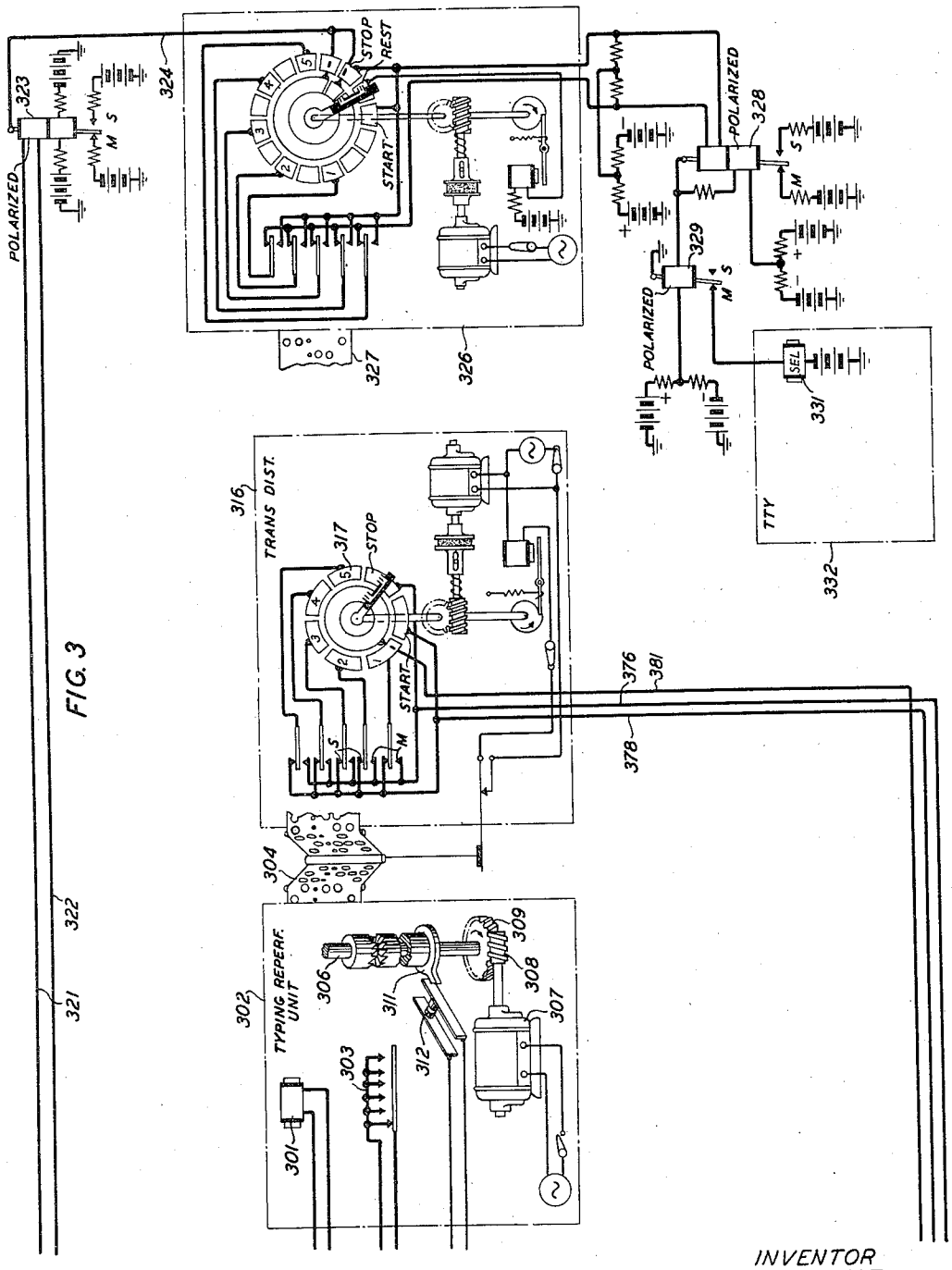


FIG. 3

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Patented May 25, 1948 2,442,301

# UNITED STATES PATENT OFFICE

2,442,301

## SYNCHRONIZING MECHANISM FOR TELEGRAPH SYSTEMS

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Application February 21, 1944, Serial No. 523,262

38 Claims. (Cl. 178—53.1)

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This invention relates to telegraph systems and particularly to systems for synchronizing the operation of telegraph transmitters and receivers.

In start-stop telegraph systems the transmitter impresses on the communication channel groups of significant or selecting impulses, each group being preceded by a start signal which is usual of spacing nature and each group being followed by a stop pulse which is usually of marking nature. The receiving device, such as a teletypewriter printer or reperforator, has a receiving distributor which is held at rest during idle line time, is released for one cycle of operation in response to each start impulse and is stopped after receiving the last significant or selecting impulse, to be restarted in response to the next start pulse. If any start impulse is lost in transmission, which may sometimes occur in wire telegraphy, but is more apt to occur in radio telegraphy, the receiving distributor will not be released for a cycle of operation so as to operate the receiving selector mechanism in timed relation to the significant impulses of the transmitted code, but will be released in response to the first spacing impulse received, which may be one of the significant impulses of the code. This will result in incorrect interpretation of the received code combination by the selector mechanism, and in the case of signals transmitted from a transmitter operating at a steady rate, such as a storage type of transmitter, several code combinations may be incorrectly interpreted before arrestment of the receiving distributor at the end of a code combination and restarting of the distributor under the control of the start impulse preceding the next code combination.

It is an object of the present invention to cause a receiving telegraph device to initiate receiving cycles substantially in unison with the transmitter when start impulses fail to be received from a transmitter normally transmitting start-stop telegraph signals at a steady rate.

When the invention as defined in the foregoing statement of objects is applied to the receiving end of a cipher telegraph system such as that disclosed in Patent No. 2,405,569, granted August 13, 1946, to K. E. Fitch et al., it creates a condition which may make desirable the modification of the apparatus at the transmitting end of the cipher system. According to the disclosure of said patent, signals to be transmitted in cipher are generated by a transmitter as plain text signals and are caused to interact with signals concurrently generated by a storage type of signal generator having in storage a random

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sequence of codes. The ciphered signals resulting from the interaction of the plain text and ciphering code combination are transmitted to the receiving station where they are caused to interact with signals generated by a storage type of signal generator having the same random sequence of codes in storage. In order for the received signals to be deciphered and plain text signals to be derived therefrom it is necessary that the same code combination interact with the code combination received in cipher that interacted with the plain text code to produce the ciphered code at the transmitting station. Accordingly, it may be desirable to prevent the ciphering signal generator at the transmitting and receiving stations from getting out of step when the apparatus, according to the invention as defined in the foregoing statement of objects, initiates cycles of operation of the distributor upon the cessation of transmission of signals including start pulses.

Accordingly, it is a further object of the present invention to cause the storage type signal generator which generates ciphering signals at the transmitting station to operate, after the generation of plain text signals ceases and without disturbing the steady idle condition of marking nature of the communication channel, for the same number of cycles that the receiving distributor is adjusted to operate after the reception of signal combinations including start impulses ceases, so that the storage type ciphering signal generator will be kept in step with the corresponding storage type signal generator at the receiving station.

The invention features electron discharge tubes controlled by adjustable condenser timing circuits for establishing the number of extra distributor cycles that will be initiated at the receiving station and at the transmitting station.

In accordance with the invention there is provided in association with the receiving relay at the receiving station a system of relays controlled by pulsing contacts associated with the receiving distributor of a teletypewriter recorder. Just before the receiving distributor reaches the end of each of its cycles the pulsing contacts are operated to cause the relay system to produce an artificial stop pulse which is applied to the selector magnet of the receiving teletypewriter printer or reperforator. Timing circuits associated with the relay system cause the artificial stop pulse to be terminated just before the beginning of the start impulse should be received from a transmitter transmitting at a uniform rate.

Thereupon other timing circuits associated with the relay system become operative to initiate just after the time when the beginning of the true start pulse should be received an artificial start pulse. If the true start pulse is received, the production of the artificial start pulse will be an idle operation. However, if the true start pulse should not be received the artificial start pulse will be produced and applied to the receiving magnet of the teletypewriter printer or reperforator, thereby releasing the receiving distributor for a cycle of rotation. In this way the receiving distributor will be kept in substantial synchronism with start-stop telegraph signals transmitted at a uniform rate even though start pulses may be lost.

An electron discharge tube controlled by a condenser timing circuit is provided for terminating the production of artificial stop and start pulses. The condenser timing circuit is under the control of the receiving relay and the condenser is discharged each time the relay is operated to spacing, thus recycling the condenser timing circuit repetitiously during the reception of signals. When the transmision of signals ceases and the receiving relay remains in the normal idle or steady marking condition the condenser timing circuit will time out and at the conclusion of the interval for which it is adjusted the electron discharge tube will be operated to cut off the production of artificial stop and start pulses by the relay circuit. The number of extra cycles of the receiving distributor that will be initiated following the cessation of signal transmission will depend upon the constants of the condenser timing circuit and these constants may be made adjustable. Thus any number of extra cycles of the receiving distributor up to a reasonable or desirable limit may be initiated.

In the foregoing brief description of the synchronizing system at the receiving station reference has been made to the reception of signals transmitted at uniform rate. This is intended to indicate the transmission of signals from a machine transmitter such as a permutation code transmitter controlled by a perforated tape. The synchronizing system at the receiving station is not well adapted to operation in connection with the reception of signals transmitted by a transmitter which may be operated irregularly, such as a keyboard transmitter, for the reason that the artificial start pulse mechanism introduces the artificial start pulse a very short interval after failure to receive the true start pulse and the introduction of artificial start pulses at regular intervals would be wholly inconsistent with operation of the receiving mechanism in response to signals transmitted at irregular intervals.

When the signals received are ciphered signals they may be applied to a reperforator, in which case the signals produced in the tape will represent the ciphered signals in the form in which they were received. As the artificial start pulse mechanism introduces extra cycles of the reperforator upon the cessation of transmission, all-marking codes will be perforated in the tape, one for each of the extra cycles. The tape produced by the reperforator is placed in a transmitter-distributor connected to a deciphering system and the signals generated by this transmitter-distributor are deciphered and the message characters are recorded by a teletypewriter printer connected to the output of the deciphering mechanism. If that portion of the perforated tape which contains the all-marking code combinations produced during the extra cycles initiated by the artificial start pulses is permitted to run through the transmitter-distributor, the extra code combinations in the tape will cause the deciphering code storage mechanism to advance one step for each code combination perforated in the tape. If the ciphering storage type signal generator at the transmitting station has been stopped upon the cessation of transmission, the deciphering signal generator at the receiving station will be out of step with it by reason of the extra cycles locally initiated.

The apparatus which may be provided at the transmitting station for preventing the occurrence of an out-of-step condition of the cipher code storage mechanisms at the transmitting and receiving stations comprises a system of relays which become effective when the generation of message signals ceases to initiate continuous operation of the cipher signal generating distributor and at the same time to hold the output of the ciphering system in the steady marking condition. Incident to each cycle of the distributor the next ciphering code in storage is brought into position to perform a ciphering operation but no signals are impressed on the communication channel. There is associated with the relay system an electron discharge tube controlled by a condenser timing circuit which begins to time when continuous operation of the ciphering distributor is started. This timing circuit is preferably adjusted to provide a number of cycles of the ciphering distributor equal to the number of extra cycles introduced at the receiver. The condenser timing circuit, upon timing out, operates the electron discharge tube which causes the relay system to arrest the ciphering distributor. Upon the resumption of transmission the ciphering distributor at the transmitter will be in step with the deciphering distributor at the receiver and no adjustments need be made upon either of these distributors to insure correct decipherment of the message at the receiving end.

For a complete understanding of the invention reference may be had to the following detailed description to be interpreted in the light of the accompanying drawings wherein:

Fig. 1 is a diagrammatic view showing a transmitting station including synchronizing mechanism in accordance with the present invention; and

Figs. 2 and 3 when placed end to end with Fig. 3 at the right of Fig. 2 are diagrammatic views showing a receiving station including synchronizing mechanism in accordance with the present invention.

Referring now to the drawings and particularly to Fig. 1, the reference numeral 11 designates a tape transmitter-distributor which may be of the type shown in Patent 2,055,567, granted September 29, 1936, to E. F. Watson. Perforated tape 12 containing signals to be transmitted by transmitter-distributor 11 may be prepared in keyboard perforator 13 which may be of the type disclosed in Patent 1,182,179, granted May 9, 1916, to C. L. Krum et al. The disclosures of these patents are incorporated herein by reference as part of the present specification.

The distributor comprises a ring of segments, one of which is the stop segment, another is the start segment and the remainder of which are code segments, a continuous collector ring and a brush arm 14 carrying interconnected brushes which bridge the segmented and continuous rings. Brush arm 14 is driven from motor 16 through clutch 17, gears 18 and 19 and shaft 21.

Shaft 21 has secured thereto a stop cam 22 which is arrestable by the armature lever 23 of a start magnet 24. The energizing circuit of start magnet 24 includes a battery 26, a manually operable switch 27 and taut tape contact 28.

The code segments of the distributor are connected to contacts which are selectively engageable by tape sensing contact tongues which are connected to ground, as is also the stop segment. The collector ring of the distributor is connected by conductor 29 to one terminal of the operating winding of a biased polar sending relay 31, the other terminal of which is connected to grounded battery 32. With a loop of tape disposed between perforator 13 and transmitter-distributor 11, so that taut tape contacts 28 are closed and with switch 27 closed, start magnet 24 will be energized and its armature lever will be withdrawn from blocking relation to stop cam 22 so that distributor shaft 21 is released for continuous rotation. The distributor will operate the armature of relay 31 to its marking or spacing contacts in accordance with the stop pulse of marking nature, the start pulse of spacing nature and the several code pulses.

The armature of transmitting relay 31, which has negative battery on its marking contact and positive battery on its spacing contact, is connected to the tip of plug 33, the sleeve of which is grounded. Plug 33 is insertable into a jack 34 connected to the keying circuit of a radio transmitter indicated symbolically by the rectangle 36. When the armature of relay 31 is on the marking contact and plug 33 is inserted into jack 34, a marking signal is transmitted by radio transmitter 36. When the armature of relay 31 is operated to its spacing contact under the control of transmitter-distributor 11 radio transmitter 36 transmits a spacing signal.

A radio receiver for receiving radio telegraph signals transmitted by radio transmitter 36 is indicated by the reference numeral 201 in Fig. 2. One of the output terminals of radio receiver 201 is connected by conductor 202, springs 1 and 2 of the right-hand set of springs of a local test key 203 and conductor 204 to one terminal of the operating winding of a biased receiving relay 206. The other terminal of the operating winding of relay 206 is connected through conductor 207, right-hand springs 4 and 5 of key 203 and conductor 208 to the other terminal of the radio receiver. The armature of relay 206 is held on its marking contact when radio receiver 201 is responding to a marking signal and is operated to the spacing contact when radio receiver 201 responds to a spacing signal. The armature of relay 206 is connected to ground. The marking contact is connected through conductors 211 and 212, left-hand contact and armature of biased polar relay 213 and conductor 214 to the tip spring of a jack 216. A path from conductor 211 to conductor 214 in shunt with the left-hand contact and armature of relay 213 is provided by relay 217 when energized, through conductor 218, middle upper armature and front contact of relay 217 and conductor 219. Jack 216 is adapted to receive plug 221, the tip and sleeve terminals of which are connected to selector magnet 301 of a teletypewriter receiving recorder 302 in Fig. 3 which may be a printing reperforator of the type shown in Patent 2,255,794, granted September 16, 1941, to R. A. Lake. The disclosure of this patent is incorporated herein by reference as part of the present specification. Typing reperforator 302 is provided with keyboard controlled transmitting



contacts 303 connected to the tip and sleeve terminals of a plug 222. Plug 222 is insertable into jack 223 which has its sleeve connected to the positive terminal of battery 224. With plug 221 inserted into jack 216 and plug 222 inserted into jack 223, a series circuit is established from battery 224 through the sleeve of jack 223 and plug 222, transmitting contacts 303, tip of plug 222 and tip spring of jack 223, sleeve of jack 216 and plug 221, selector magnet 301, tip of plug 221 and tip spring of jack 216, conductor 214, armature and left-hand contact of relay 213, conductor 212, conductor 211 and armature and marking contact of relay 206 to ground. Jacks 216 and 223 have closed circuit contacts so that battery 224 is always connected through to the marking contact of relay 206 whether either or neither of the plugs 221 and 222 is inserted into the jacks 216 and 223, respectively, provided the path through the armature and left-hand contact of relay 213 or the path through the middle upper armature and front contact of relay 217 or both paths are closed. With plug 221 inserted into jack 216 selector magnet 301 of printing reperforator 302 will be responsive to relay 206 and a message transmitted from tape transmitter-distributor 11 in Fig. 1 will be perforated in the tape 304 and will be printed on the tape so as to be readable therefrom.

The receiving distributor shaft 306 of printing reperforator 302, which is driven from motor 307 through gears 308 and 309, is provided with a cam 311 which is rotated through one revolution for each receiving cycle of the typing reperforator. Cam 311 is arranged to momentarily close pulsing contacts 312 and the orientation of cam 311 with respect to the receiving distributor mechanism (not shown) carried by shaft 306 is such that the contacts close and reopen just before the distributor shaft reaches its stop position. Contacts 312 are connected to the tip and sleeve of plug 226 which is insertable into jack 227 and the function of contacts 312 is to initiate the operation of synchronizing mechanism now to be described.

The synchronizing mechanism is primarily under the control of relay 217 from the standpoint of being in the operative or inoperative condition. When relay 217 is energized the synchronizing mechanism is disabled but when the relay is released the synchronizing mechanism becomes operative. One terminal of the winding of relay 217 is connected to ground and the other is connected to the armature of a relay 228 and to one of the contact springs of a key 229. Key 229 is a locking key and when it is operated to engage its contact, battery 231 is connected to relay 217 to hold the relay energized. Relay 217 is also energizable through the armature and left-hand contact of relay 228, right-hand and lower left-hand break contacts in series of timing test key 232 to battery 233 which has the same polarity as battery 231. One terminal of the winding of relay 228 is connected to positive battery 234 and the other terminal is connected to the anode of an electron discharge tube 236 which is preferably a vacuum tube. The cathode of tube 236 is connected to ground. The grid of tube 236 is connected through resistor 237 to a condenser charging circuit comprising condensers 238 and 239 connected in parallel and connected to ground through common resistor 241, and to ground through resistor 242 and battery 243 having its positive terminal connected to resistor 242 and its negative terminal connected to ground. The

junction of resistor 237 and the condenser charging circuit is connected through resistor 244 having a high resistance value and conductor 246 to the spacing contact of receiving relay 206.

With relay 206 maintained in the steady marking condition during its idle interval ground connection supplied through the armature of relay 206 is disconnected from conductor 246 and condensers 238 and 239 are permitted to charge from battery 243. As the condensers become charged the grid of the tube 236 is made more positive with respect to the cathode until tube 236 will draw sufficient current to operate the armature of relay 228 to the left-hand contact. From this it will be apparent that after an idle interval of relay 206 during which the armature is held on the marking contact, relay 228 will be operated to its left-hand contact and relay 217 will be operated whether or not key 229 is closed.

It will now be assumed that key 229 is open so that battery 231 is disconnected from the winding of relay 217 and that signal transmission from tape transmitter-distributor 11 in Fig. 1 is started. When the armature of relay 206 goes to spacing in response to the start pulse of the first code combination received ground on the armature of relay 206 is connected through conductor 246 and resistor 244 to the condenser charging circuit to discharge condensers 238 and 239. The system will be described as if resistor 244 were omitted and the reason for the provision of that resistor will be set forth later. With ground on the armature of relay 206 connected directly to the condenser charging circuit the condensers would discharge very quickly, bringing the potential of the grid of tube 236 down to that of the cathode and reducing the current through tube 236 to a value insufficient to maintain the armature of relay 228 on its left-hand contact. Accordingly, the armature moves away from this contact, interrupting the energizing circuit of relay 217 and releasing that relay. At the outer upper armature and back contact of relay 217 a conductive path is established from conductor 218 to the left-hand contact of a biased polar relay 247. At the middle upper armature and front contact the shunt around the left-hand contact and armature of relay 213 is interrupted. At the inner upper armature and back contact of relay 217 a circuit is completed from grounded battery 248 through lamp 249 to ground. Lamp 249 is lighted over this circuit to indicate that the synchronizing mechanism is in operative condition. At the lower armature and back contact of relay 217 a short-circuiting path is established around resistor 244.

As the marking and spacing pulses are received by relay 206 they are repeated to the selector magnet 301 of printing reperforator 302, the receiving distributor of the reperforator, driven by shaft 306 being released for rotation in response to the start pulse, this distributor including the cam 311. During each marking pulse received by relay 206, condensers 238 and 239 begin to charge through resistor 242 and each time the armature of relay 206 goes to spacing condensers 238 and 239 are quickly discharged, the resistor 244 being short-circuited by the lower armature of relay 217.

Just before the receiving distributor of printing reperforator 302 reaches its stop position it momentarily closes contacts 312, thus completing a circuit from battery 224 through the sleeve of jack 227, sleeve of plug 226, contacts 312, tip of plug 226, tip spring of jack 224, conductor 251 and lower or operating windings of biased polar relays 252 and 253 to ground. These relays have their biasing windings connected in a circuit from battery 254, biasing windings of biased polar relays 256 and 213, conductor 257, biasing windings of relays 252 and 253 to ground. In the absence of current through the operating windings of relays 252 and 253 the armature of relay 252 is held on its right-hand contact and the armature of relay 253 is held on its left-hand contact by current through their biasing windings. Upon the completion of the circuit of the operating windings of these relays, the armature of relay 252 is operated to its left-hand contact and the armature of relay 253 is operated to its right-hand contact. Relay 252 establishes a holding circuit for itself and for relay 253 from battery 258 of the same polarity as battery 224 through the right-hand contact and armature of a biased polar relay 259. Relay 253 upon moving away from its left-hand contact disconnects ground from a circuit including conductor 261, conductor 262 and operating windings of biased polar relays 247 and 263 in series to grounded battery 264. Prior to the operation of relay 253 the operating windings of relays 247 and 263 were energized over this circuit to hold the armatures on their left-hand contacts. At the junction of conductors 261 and 262 there is a connection through condenser 266 and resistor 267 to ground. Although ground is disconnected from conductor 261 by the operation of the armature of relay 253 away from its left-hand contact, charging current for condenser 266 flows through the operating windings of relays 247 and 263, maintaining the armatures of these relays operated to their left-hand contacts. Upon the movement of the armature of relay 253 into engagement with its right-hand contact a conductive path is established from ground through the noted armature and right-hand contact and conductor 268 to the armatures of relays 247 and 263. The left-hand contact of relay 263 has no connection but the left-hand contact of relay 247 is connected through the outer upper armature and back contact of relay 217 and conductor 218 to conductor 212 which is in the circuit of the selector magnet 301 of printing reperforator 302. With the ground connection from the armature of relay 253 extended over this path the selector magnet 301 of printing reperforator 302 is placed in the marking condition independently of the instantaneous condition of relay 206 and this represents the local generation of an artificial stop pulse for the printing reperforator.

As the charging current for condenser 266 decreases the biasing winding of relays 247 and 263 will assume control of these relays and operate the armatures to the right-hand contacts. The circuit of the biasing winding of relay 247 includes an adjustable resistor 271 which is so adjusted that the biasing winding will dominate the armature and move it to the right-hand contact, which has no connection, an instant before the true stop pulse received by relay 206 should be terminated by reception of the beginning of the start pulse, assuming that the distributor of tape transmitter-distributor 11 is operating continuously. As the armature of relay 247 leaves its left-hand contact the ground connection supplied by the armature of relay 253 is removed from conductor 212, restoring the selector magnet 301 of printing reperforator 302 to control by receiving relay 206. If the start pulse transmitted from tape transmitter-distributor 11 is re-

ceived at the proper time, relay 206 will repeat this pulse to the selector magnet 301, releasing the receiving distributor of printing reperforator 302 for another cycle of operation.

The circuit of the biasing winding of relay 263 includes an adjustable resistor 272. This resistor is so adjusted that the biasing winding will dominate the armature and move it to the right-hand contact an instant after the true start pulse should have been received by relay 206. With the armature of relay 263 moved to the right-hand contact, a circuit is established from ground on the armature of relay 253 through the right-hand contact of that relay, conductor 268, armature and right-hand contact of relay 263 and operating windings of relays 213 and 256 to battery 254. Prior to the energization of the operating windings of these relays their armatures are held on their left-hand contacts by the biasing windings in the circuit previously traced including conductor 257. With the armature of relay 213 disengaged from its left-hand contact the conductive path from the marking contact of receiving relay 206 to the selector magnet 301 of printing reperforator 302 is interrupted. This represents the initiation of the artificial start pulse. If the true start pulse has been received, the energizing circuit of selector magnet 301 will have been interrupted by relay 206 before the armature of relay 213 is operated away from its left-hand contact and the latter operation will have no effect. If, however, the true start pulse has not been received and the relay 206 has remained in the marking condition beyond the time at which the true start pulse should have been received, the relay 213 will interrupt the energizing circuit of selector magnet 301 and thus introduce the artificial start condition.

Relay 256, in operating its armature away from the left-hand contact concurrently with the operation of relay 213, interrupts a circuit from ground through resistor 273, armature and left-hand contact of relay 256, conductors 269 and 270, and operating winding of relay 259 to battery 258. From the junction of conductors 269 and 270 there is a connection to ground through condenser 274 and resistor 275. Charging current for this condenser flows through the operating winding of relay 259 and maintains the armature of that relay operated to the right-hand contact until the condenser charging current has decreased to such value that the current in the biasing winding of relay 259 dominates the armature. The circuit of the biasing winding of relay 259 includes resistors of such value that the biasing winding assumes control over the armature of the relay and moves the armature away from its right-hand contact to its unconnected left-hand contact about the middle of the true start pulse if received, which affords a sufficient interval from the time of operation of relay 213 away from its left-hand contact to insure the release of selector magnet 301 by relay 213 if the true start pulse has not been received. In operating its armature away from the right-hand contact the relay 259 interrupts the holding circuit of the relays 252 and 253 and these relays restore their armatures to the position shown in Fig. 2. Relay 252 further interrupts the holding circuit in preparation for restoration of the armature of relay 259 to its right-hand contact and relay 253 reestablishes the energizing circuit for the operating windings of relays 247 and 263. Condenser 266 quickly discharges to ground through the left-hand contact and armature of relay 253 and the armatures of relays 247 and 263 are immediately operated to their left-hand contacts. Relay 247, restored to the condition shown in Fig. 2, again completes the path from the right-hand contact of relay 253 to conductor 212 in preparation for the production of the next artificial stop pulse. Relay 263 interrupts the circuit for the energizing windings of relays 213 and 256 and the biasing windings of these relays quickly restore the armatures to the left-hand contacts. Relay 213 reconnects the selector magnet 301 to the marking contact of receiving relay 206, thus terminating the artificial start pulse and restoring the selector magnet to control by the receiving relay. Relay 256 reestablishes the energizing circuit for the operating winding of relay 259 and condenser 279 quickly discharges to ground, and relay 259 immediately operates its armature to the right-hand contact thus completing the restoration of the artificial stop and start pulse producing relay system to normal.

By means of the contacts 312 and the system hereinbefore described comprising relays 213, 247, 252, 253, 256, 259 and 263 an artificial stop pulse is produced in every receiving cycle and an effort is made to produce an artificial start pulse. If a true start pulse has been received, it is effective to restart the printing reperforator 302 and mask the artificial start pulse. If a true start pulse is lost during transmission and is not received, the relay system introduces the artificial start pulse an instant after the true start pulse should have been received and thus permits the selector mechanism of the printing reperforator to receive and correctly interpret code pulses as if the true start pulse had been received.

At the end of message transmission when transmitter-distributor 11 in Fig. 1 is stopped relay 206 will remain in the steady marking condition in the absence of any disturbances on the radio transmission channel which might operate the armature of relay 206 to spacing. Near the end of the cycle of operation of the receiving distributor of printing reperforator 302 in response to the final code combination transmitted, contacts 312 will be closed momentarily and will initiate a cycle of operation of relays 213, 247, 252, 253, 256, 259 and 263. When relay 247 operates its armature to its right-hand contact, the artificial stop pulse which it seeks to produce will be masked by the steady marking condition of relay 206 in response to the idle condition of marking nature. Thereafter when the armature of relay 263 is operated to the right-hand contact and operates relay 213 that relay will disconnect the selector magnet 301 from the marking contact of relay 206, thus introducing the artificial start pulse and releasing the receiving distributor of the printing reperforator 302 for another cycle of operations. Upon the restoration of relay 213 to normal as relay 259 operates, the selector magnet 301 is reconnected to the marking contact of relay 206 and the selector mechanism of the printing reperforator interprets the signal received during this cycle as the all marking signal combination and perforates the all marking combination in tape 304. At the end of this cycle contacts 312 again are closed momentarily and initiate another cycle of operation of the synchronizing relay system, thus introducing another artificial start pulse and another receiving cycle of a printing reperforator. This sequence of operation continues.

With the armature of relay 206 remaining on its marking contact steadily, condensers 238 and

239 gradually charge from battery 243 through resistor 242 because they are afforded no opportunity to be discharged. As these condensers become charged they raise the potential of the grid of tube 236 with respect to the cathode until the tube draws sufficient current to operate the armature of relay 228 to the left-hand contact. The interval elapsing between the final operation of relay 206 to the marking contact, the operation of relay 228 to its left-hand contact will depend upon the capacitance of the condenser system. The interval may be reduced by removing one of the condensers 238 and 239. It may be increased by adding one or more condensers in parallel with the condensers 238 and 239. If desired, a single variable condenser of relatively large capacitance or two or more individually variable condensers connected in parallel may be substituted for condensers 238 and 239 to provide for varying the number of extra artificial start pulses and extra cycles of printing reperforator 302 that are to be permitted to occur before relay 228 operates its armature to the left-hand contact. When relay 228 becomes operated by tube 236 it reestablishes the energizing circuit for relay 217 which operates. At its outer upper armature, the relay 217 interrupts the artificial stop pulse circuit. At its middle upper armature it reestablishes the shunt around the left-hand contact and armature of relay 213. At its inner upper armature it extinguishes lamp 249. Finally at its lower armature it removes the short-circuit around resistor 244. Thereafter when relay 213 is operated away from its left-hand contact by relay 263, an artificial start pulse will not be produced because electromagnet 301 of the printing reperforator remains connected to the marking contact of receiving relay 206 through the middle upper armature and front contact of relay 217 establishing a shunt path around the armature and left-hand contact of relay 213. Thus the printing reperforator will remain at rest.

Reference is now made to the provision of resistor 244 between the spacing contact of relay 206 and the condenser charging circuit comprising condensers 238 and 239, resistor 242 and battery 243. The resistor 244 when not shunted by the armature of relay 217, which is the condition when the synchronizing system is not in operation, prevents the substantially instantaneous discharging of condensers 238 and 239 to ground when the armature of relay 206 goes to spacing, and permits the charge to leak off slowly, for the value of resistor 244 is such that relay 206 must respond to several code combinations during which the armature of relay 206 has operated to spacing an average number of times before a sufficient quantity of the charge on condensers 238 and 239 has leaked off to ground to reduce the potential of the grid of tube 236 and the plate current in that tube to a value at which the armature of relay 238 will no longer be maintained on its left-hand contact and will accordingly release relay 217. This delayed interval in the release of relay 217 will depend upon the number of spacing intervals occurring in the first few codes received by relay 206. The larger the percentage of spacing pulses the more quickly will relay 217 be released. When it does release, the lower armature short-circuits resistor 244 and thereby provides for substantially instantaneous discharge of any charge induced on condensers 238 and 239 during marking intervals, so that no charge will be gradually accumulated on the condenser during signal reception, to reduce the number of extra cycles which the synchronizing relay system will introduce after signal reception ceases. The principal purpose of resistor 244 is to prevent stray disturbances which may operate the armature of relay 206 to spacing momentarily during idle intervals, when no signals are being received, from instantaneously discharging condensers 238 and 239 and thus effecting the release of relay 217. Response of relay 206 to such disturbances may result in interruption of the energizing circuit for electromagnet 301 of the printing reperforator, so that the receiving distributor of the reperforator is released and contacts 312 are closed momentarily near the end of the cycle. If relay 217 should also be released, the synchronizing relay circuit would be activated and the predetermined number of extra cycles of the printing reperforator would be performed just as they are when transmission ceases. By providing for the slow discharge of condensers 238 and 239, undesired operation of the reperforator in this manner is prevented. The fact that the synchronizing relay system is not activated as soon as signals begin to be received by relay 206 is not considered disadvantageous because it does become activated after a few code combinations have been received and it is considered preferable to risk loss of a start pulse during these few codes and possible resulting garbling of a few received signals than it would be to permit activation of the synchronizing relay system and introduction of a number of idle operations of printing reperforator 302 in response to disturbances having the effect of operating relay 206 to spacing.

The description thus far has contemplated the transmission of plain text signals from transmitter-distributor 11 in Fig. 1 to repeating relay 206 in Fig. 2, there being no ciphering feature involved. Under these circumstances there may or may not be any occasion for reperforating tape at the receiving station and accordingly instead of printing reperforator 302, a teletypewriter printer such as that disclosed in Patent 1,745,633, granted February 4, 1930, to S. Morton et al., or such as that disclosed in Patent 1,904,164, granted April 18, 1933, to S. Morton et al. may be provided. The disclosures of these patents are incorporated herein by reference as part of the present specification. If a teletypewriter printer having no reperforator feature is substituted for printing reperforator 302, the selector magnet of the teletypewriter printer will be connected to plug 221 instead of selector magnet 301 and the keyboard transmitter contacts will be connected to plug 222 instead of transmitter contacts 303. In the case of the substitution of either printer there must be added to the receiving distributor assembly a cam similar to the cam 311 for operating contacts 312.

When messages are to be transmitted in cipher, the plain text signals must undergo a ciphering operation before being transmitted. The ciphering system is shown in the lower portion of Fig. 1 to which reference is now made. Reference numeral 41 designates a tape transmitter-distributor which may be similar to the tape transmitter-distributor 11 and may receive perforated tape 42 containing plain text signals perforated by the keyboard perforator 43.

The continuous ring of distributor 40 of transmitter-distributor 41 is connected by conductor 44 to one terminal of a biased polar relay 46, the other terminal of which is connected to positive

battery 47. Ground is connected to the stop segment and to the transmitting contact tongues of the transmitter-distributor. In Fig. 1 the ground connection is supplied through a relay system which comprises a synchronizing device, but as the present description is concerned immediately only with the generation of ciphering signals, the fact that the ground connection is supplied through a relay system will be disregarded, and the transmitter-distributor 41 will be considered as if having ground directly on its stop segment and transmitting contact tongues in conformity with transmitter-distributor 11. The reason for presenting the description in this way is that it is within the contemplation of the invention to transmit ciphered signals and receive them on reperforator 302 of Fig. 3 having the synchronizing system of Fig. 2 associated therewith without employing at the transmitting station a synchronizing circuit shown in Fig. 1 and to be described hereinafter.

Relay 46 has negative and positive polarities of battery on its marking-spacing contacts respectively and operates its armature between these contacts under the control of tape transmitter-distributor 41. The armature of relay 46 is connected by conductor 48 to the inner ring of the distributor 50 of a tape transmitter-distributor 49 which serves as a cipher signal generator and is provided with a perforated tape 51 having a random sequence of codes perforated therein for ciphering plain text codes generated by the transmitter-distributor 41. The distributor 50 of the cipher signal generator 49 differs from those hereinbefore, described in that it is provided with a rest segment, in addition to the start and stop segments, to which one terminal of the start magnet 52 is connected, and is also different in that the start, stop and code segments are shorter and there are intervening free or dead segments. When relay 46 is operated to spacing in response to the start pulse of a code combination generated by tape transmitter-distributor 41, a circuit is completed from positive battery on the spacing contact of the relay through conductor 48, continuous ring, bridging brushes and the rest segment of the distributor 50, and winding of start magnet 52 of that distributor to negative battery 53. This causes start magnet 52 to be energized whereby the distributor brush arm is released for one cycle of rotation. These brushes immediately encounter the start segment and complete a circuit from positive battery on the spacing contact of relay 46, through conductor 48, continuous ring, bridging brushes and start segment of the distributor, conductor 56 and then through branching paths, one of which comprises resistor 57 and the other of which comprises the operating winding of a polar relay 58 and resistor 59 in series therewith, the paths rejoining at the junction of resistors 57 and 59 and continuing through conductor 61 to a potential divider comprising batteries 62 and 63 and resistors 64 and 65. With positive polarity supplied over the path just traced to the upper terminal of the operating winding of relay 58, the armature of that relay is operated to spacing. The marking contact of relay 58 has negative polarity and the spacing contact has positive polarity and the armature is connected by conductor 67 to the tip of a plug 68 which is insertable into jack 34 of radio transmitter 36 for controlling the keying circuit of the transmitter. The sleeve of plug 68 is connected to a potential divider comprising batteries 71 and 72 and resistors 73 and 74. The armature of relay 58 is also connected through the locking winding of that relay to a potential divider comprising batteries 76 and 77 and resistors 78 and 79 and the polarities are such that the locking winding seeks to hold the armature on either of the marking and spacing contacts as the armature engages those contacts, but the locking winding is subordinate to the operating winding so that the operating winding will move the armature from one to the other of the contacts in spite of the opposition of the locking winding.

The distributor 50 rotates in substantial synchronism with the distributor 40 and by means of its contact tongues, which sense the ciphering code combinations in tape 51, selectively connects the armature of relay 46 to the upper or lower terminals of the operating winding of relay 58 and the outer ends of the resistors 57 and 59 bridged across the operating winding. There are four possible operating conditions. When the armature of relay 46 engages the marking contact and is connected by the transmitting contacts and segments of the distributor over conductor 56 to the upper terminal of the operating winding of relay 58, the relay is operated to marking. When the armature of relay 46 engages the spacing contact and the armature is connected over the same path, the relay 58 is operated to spacing. When the armature of relay 46 engages the marking contact and the circuit is extended over conductor 54 to the lower terminal of the operating winding of relay 58, relay 58 is operated to spacing. Finally, when the armature of relay 46 engages the spacing contact and the circuit is extended over conductor 54 to the lower terminal of the operating winding of relay 58, the relay is operated to marking. The summary of these four conditions of operation of relay 58 is that when relay 46 and cipher signal generator generate like signals, whether marking or spacing, relay 58 is operated to marking and when relay 46 and cipher signal generator 49 generate unlike signals, either generating a marking signal and the other generating a spacing signal, relay 58 is operated to spacing.

When the brushes of the distributor 50 reach the stop segment, relay 46 will be receiving the stop signal from tape transmitter-distributor 41 and will be in the marking condition, applying negative polarity through its marking contact and armature and over conductor 48, the inner ring and stop segment of distributor and conductor 56 to the junction of resistor 57 and the upper terminal of the operating winding of relay 58. The circuit is the same as that traced for the generation of the start pulse but the polarity is reversed so that relay 58 will be operated to marking transmitting the stop pulse.

The ciphered signals are transmitted by radio transmitter 36, are received by radio receiver 201 and are recorded by printing reperforator 302 in tape 304 in the form of perforations, the synchronizing mechanism of Fig. 2 hereinbefore described operating to keep printing reperforator 302 in substantial synchronism with tape transmitter-distributor 41 and cipher signal generator 49 in case the start pulses are lost during transmission, and also operating to introduce extra cycles of printing reperforator 302 at the conclusion of transmission. The signals appearing as perforations in tape 304 will be in cipher except those resulting from the extra cycles of operation of printing reperforator 302 after sig-

nal reception ceases, which will be unciphered all-marking signal combinations.

In order for the signals perforated in tape 304 to be deciphered, they must be transmitted by a tape transmitter-distributor into a deciphering mechanism. Accordingly, as shown in Fig. 3, there is provided at the receiving station, a tape transmitter-distributor 316 which may be similar to the tape transmitter-distributors 11 and 41 in Fig. 1. It differs from those transmitter-distributors by being arranged for the generation of polar signals and accordingly has both marking and spacing contacts which the tape sensing contact tongues are arranged to engage selectively under the control of perforations in tape 304. The marking contacts and the stop segment are connected through conductor 376, conductor 276, break contacts 5 and 6 on the left-hand side of local test key 203, to negative battery 277. The spacing contacts and start segment of tape transmitter-distributor 316 are connected through conductors 378 and 278 to positive battery 279. The inner ring of the distributor 317 of tape transmitter-distributor 316 is connected by conductors 381 and 281, upper left-hand break contacts of timing test key 232, conductor 282, left-hand contacts 2 and 3 of local test key 203, conductor 283, right-hand contacts 8 and 9 of local test key 203 and conductor 284 to the tip spring of jack 286. The sleeve of jack 286 is connected by conductor 287 and right-hand contacts 11 and 12 of local test key 203 to a potential divider comprising batteries 288 and 289 and resistors 291 and 292.

Jack 286 is adapted to receive plug 293 which is connected by conductors 321 and 322 to the operating winding of a biased polar relay 323. Relay 323 has negative and positive polarities, respectively, on its marking and spacing contacts and its armature is connected by conductor 324 to the inner ring of the distributor of a cipher signal generator 326 which may be identical with the cipher signal generator 49 shown in Fig. 1 and which is provided with perforated tape 327 containing perforated signal codes in a sequence identical with those in the tape 51. Relay 323 and cipher signal generator 326 jointly control a relay 328 in the same manner that relay 46 and cipher signal generator 49 control relay 58 in Fig. 1. When relay 323 receives a ciphered code combination from tape transmitter-distributor 316 and jointly with the cipher signal generator 326 controls relay 328, the cipher signal generator 326 then sensing the same cipher code combination that produced the ciphered signal, the received signal will be deciphered and relay 328 will generate the same plain text code that relay 46 received from tape transmitter-distributor 41. Relay 328 has negative and positive polarities on its marking and spacing contacts, respectively, and its armature is connected through the winding of a polar relay 329 to a potential divider circuit and also through the locking winding of relay 328 to a similar potential divider circuit. The armature of relay 329 is connected to ground and the marking contact is connected to battery through the selector magnet 331 of a teletypewriter printer 332 which may be of the type shown in either of the Morton et al. patents hereinbefore identified. As relay 328 generates the plain text signals, derived from the ciphered signals received by relay 323, it will operate relay 329 which in turn controls selector magnet 331 and causes teletypewriter printer 332 to record the received message in plain text.

Following the transmission by tape transmitter-distributor 316 of the last received code combination of the message, the all-marking signal combinations will be transmitted through relay 323 until the taut tape mechanism of transmitter-distributor 316 interrupts transmission. This will occur unless an attendant closely watches the passage of tape 304 through transmitter-distributor 316 and stops the transmitter before transmission of the first of the all-marking signal combinations which were produced during the extra cycles of printing reperforator 302. It may not be feasible to have an attendant supervising transmitter-distributor 316 as closely as this and accordingly it is assumed that the all-marking code combinations will be transmitted. Each of these code combinations will be repeated by relay 323 to control relay 328 jointly with cipher signal generator 326 and the distributor of cipher signal generator 326 will operate through one cycle for each such code combination, tape 327 being advanced one step for each cycle. It will be apparent that the code combinations repeated by relay 328 to relay 329 and by relay 329 to selector magnet 331 will not be all-marking code combinations because the ciphering code in tape 327 will act upon these all-marking codes, but under the previously described method of ciphering herein employed wherein two like pulses interact to produce a marking pulse and two unlike pulses interact to produce a spacing pulse, any code combination which interacts with the all-marking code combination is regenerated unchanged. Accordingly, the signals in ciphering tape 327 will be transmitted to selector magnet 331 unchanged and the characters recorded will be those represented by the codes in ciphering tape 327. Since the sequence of codes in this tape is assumed to be random, these characters will convey no intelligence and there will be no difficulty in identifying the end of the received message.

Since the tape 327 has been advanced one step for each reception by relay 323 of one of the all-marking code combinations it will now be out of step with tape 51 in cipher signal generator 49 at the transmitting station and these two tapes must be rephased by agreement between the attendants at the two stations by intercommunication in plain text before further transmission in cipher is possible. To obviate the necessity of rephasing the cipher tapes a synchronizing system shown in Fig. 1 has been provided and will now be described.

The synchronizing system comprises relays 101, 102, 103, 104 and 106. The relays 104 and 106 are included in the plate circuits of electron discharge tubes 107 and 108, respectively, and neither of these relays has a locking circuit, so that they will be conductive only when the grids of their associated electron discharge tubes which are preferably vacuum tubes are sufficiently positive with respect to the cathodes to cause the tubes to draw enough current to operate the relays. The idle or steady-state condition of the synchronizing system, which exists when all battery connections to the synchronizing system are complete, transmitter-distributor 41 is idle and has been idle for an appreciable period of time and the taut tape contacts 109 or the manually operable switch 111 in series therewith are open, is that relays 101, 103, 104 and 106 are energized and relay 102 is released, and the relays are shown in Fig. 1 in this condition. The energizing circuit for relay 101 is traced from bat-

tery 47 through the operating winding of relay 46, conductor 44, collector ring, bridging brushes and stop segment of the distributor 40, conductor 112, winding of relay 101, conductors 113 and 114 and armature and front contact of relay 104 to ground. The energizing circuit of relay 103 is traced from battery 116 through the front contact and lower armature of relay 101, back contact and outer upper armature of relay 102, conductor 117, conductor 118 and winding of relay 103 to ground. A holding circuit for relay 103 is also traced from battery 119 through the front contact and innermost upper armature of relay 103, conductor 121, outer lower armature and back contact of relay 102, conductor 118 and winding of relay 103 to ground. With relay 103 energized ground on the back contacts associated with the middle and outer lower armatures of relay 103 is disconnected from condenser charging circuits which will be specifically identified hereinafter and which are associated with the grids of tubes 107 and 108. The condensers associated with these grids are assumed to be fully charged, so that tubes 107 and 108 are conductive and relays 104 and 106 are operated. Relay 106 has prepared a path from the open taut tape contacts 109 through conductors 122, 123, 124, front contact and armature of relay 106, conductors 126 and 127 and winding of relay 102 to ground.

When a message is to be transmitted, keyboard perforator 43 is operated to perforate signals representing the message in tape 42 and as a loop of tape accumulates between perforator 43 and tape transmitter-distributor 42, taut tape contacts 109 will close. If manually operable switch 111 is also closed, battery 128 will be connected over the path just traced to operate relay 102. At its outer upper armature and back contact relay 102 interrupts the energizing circuit for relay 103 traced from battery 116 through the lower armature and front contact of relay 101, back contact and outer upper armature of relay 102, conductors 117 and 118 through the winding of relay 103 to ground. At its inner upper armature and front contact relay 102 completes its holding circuit from battery 128 through switch 111 and taut tape contacts 109, conductor 122, front contact and inner upper armature of relay 102, conductors 129 and 127, and winding of relay 102 to ground. At its outer lower armature the relay 102 interrupts the holding circuit for relay 103 traced from battery 119 through the inner upper armature and front contact of relay 103, conductor 121, outer lower armature and back contact of relay 102, and conductor 118 and winding of relay 103 to ground. With the energizing and holding circuits both interrupted, the relay 103 releases. Relay 102 also completes a circuit from battery 131 through its inner lower armature and front contact, conductor 132 and winding of start magnet 133 of tape transmitter-distributor 41 to ground. Magnet 133 releases the distributor shaft of tape transmitter-distributor 41 for rotation to transmit the code combination perforated in tape 42.

With relay 103 released a conductive path is prepared from battery 136, the outermost upper armature and back contact of the relay, conductor 137, upper armature and front contact of relay 101, conductors 138 and 123 to the inner upper front contact of relay 102. This path parallels the holding path for relay 102 from battery 128 when relay 101 is energized. At the middle upper armature and back contact of relay 103 ground is connected over conductors 139 and 113 to the winding of relay 101 to provide for completion of the circuit of the operating winding of relay 46 when relay 104 shall have been released. At its innermost lower armature and front contact relay 103 interrupts a path from positive battery 141 over conductor 142 and conductor 54 to the junction of resistor 59 and the lower terminal of the operating winding of relay 58. The function of this connection which relay 103 interrupts upon being released has been to hold relay 58 in the marking condition when relay 46 operates to spacing under circumstances which will be described later. At the middle and outermost lower armatures of relay 103 ground becomes connected to the previously mentioned condenser charging circuits, discharging the condensers and grounding the grids of electron discharge tubes 107 and 108 to reduce the plate current through those tubes and thereby release relays 104 and 106.

When the brushes of the distributor 40 move off the stop segment the energizing circuit for relay 101 is interrupted and this relay releases. The effect of this is merely to interrupt one of the two holding paths for relay 102 so that the relay does not release. Relay 101 does not become energized during the time that the brushes of the distributor are traversing the code segments because its energizing circuit is opened at the stop segment of the distributor, and the energizing circuit of relay 46 is completed during marking intervals through contacts of the distributor and through conductors 143, 113 and 139, back contact and middle upper armature of relay 103.

Each time that the brushes of the distributor traverse the stop segment relay 101 is energized and then released, but this effects no change in the condition of the other relays of the synchronizing system while switch 111 or taut tape contacts 109 remain closed. The signals generated by tape transmitter-distributor 41 are ciphered by cipher signal generator 49 and are applied to the radio transmitter through plug 68 and jack 34 in the manner hereinbefore described. The condition of the synchronizing circuit during transmission of signals is that relay 101 is energized and released once per cycle of the distributor, relay 102 remains energized and relays 103, 104 and 106 remain released. As long as switch 111 remains closed and taut tape contacts 109 remain closed, relay 102 will be held energized. If switch 111 should be opened by manual operation to interrupt transmission, or if keyboard perforator 43 should not be operated with sufficient rapidity to keep up with transmitter-distributor 41, or if the perforation of the message in tape 42 should be completed and the operation of keyboard perforator 43 suspended, the holding circuit of relay 102 will be interrupted, whether by the manual opening of switch 111 or the opening of taut tape contacts 109 due to reduction of the loop in tape 42 between perforator 43 and transmitter-distributor 41. If interruption of the holding circuit of relay 102 occurs while the brushes are traversing, the stop segment and relay 101 is energized, relay 102 will not be released immediately because relay 101 provides an alternate holding path for relay 102 as previously explained. If the distributor brushes are off the stop segment or when they move off the stop segment, relay 101 will be released and there will be no holding path for relay 102 which will also release. At the outer upper armature and back

contact, relay 102 prepares an energizing circuit for relay 103 and at the outer lower armature and back contact it prepares a holding circuit for this relay. At the inner upper armature and front contact relay 102 interrupts its own holding path and at the inner lower armature and front contact it interrupts the energizing circuit of start magnet 133 which releases. This causes the distributor brushes to be arrested when they reach the stop segment. As the distributor brushes reach this segment relay 101 becomes energized and completes the energizing circuit of relay 103 from battery 116 through the front contact and lower armature of relay 101.

Relay 103 completes its holding circuit from battery 119 through its innermost upper armature and front contact and the lower outer armature and back contact of relay 102 so that relay 103 remains energized. Relay 103 connects positive battery 141 over its innermost lower armature and front contact and conductors 142 and 154 to hold the armature of relay 58 on its marking contact. Relay 103 opens the energizing circuit of relay 101 and of the operating winding of relay 46 in series therewith by disengagement of the grounded middle upper armature of relay 103 from its back contact. This causes relay 46 to operate to and remain in its spacing condition, completing the energizing circuit for start magnet 52 of cipher signal generator 49 and releasing the distributor 50 for rotation. The brushes of this distributor traverse its segments without changing the condition of relay 58 because the positive polarity supplied through the spacing contact and armature of relay 46 is selectively connected through the distributor to conductor 56, opposing the potential supplied to conductor 54 from battery 141 and reducing to zero the current through the operating winding of relay 58, which is held on its marking contact by the current through the lower or locking winding, or connecting the spacing battery of relay 46 to conductor 54 in parallel with battery 119. Upon the return of the brushes of the distributor to the rest segment, start magnet 52 is reenergized and the distributor brushes are released for another cycle. Incident to each cycle of the distributor tape 51 is advanced one step but no signals are transmitted by relay 58.

At the time of operation of relay 103, its outer lower armature disconnected ground from the grid of tube 107 and its middle lower armature disconnected ground from the grid of tube 108. The grid of tube 107 is connected through variable resistor 161 and battery 162 from positive to negative polarities to ground and through condenser 163 and resistor 164 to ground. With the removal of ground from the grid of tube 107, condenser 163 begins to charge through resistor 161, raising the potential of the grid with respect to the cathode of the tube. The capacitance of condenser 163 is such and variable resistor 161 is so adjusted that starting from the fully discharged condition of condenser 163 tube 107 will be rendered sufficiently conductive to operate relay 104 upon completion by the distributor 50 of the same number of cycles that are performed by printing reperforator 302 under the control of the synchronizing relay circuit in Fig. 2 with condensers 238 and 239 starting from the fully discharged condition and relay 206 remaining steadily on its marking contact. When relay 104 is operated it connects ground over conductors 114 and 113, through the winding of relay 101, conductor 112, stop segment and continuous ring



of distributor 40, and conductor 44 to the operating winding of relay 46 to reenergize relay 101 and to restore relay 46 to the marking condition. With relay 46 restored to the marking condition, start magnet 52 of cipher signal generator 49 will not be energized when the distributor brushes reach the rest segment and accordingly the distributor will be stopped. In this way the tape 51 is advanced a number of steps equal to the number of all-spacing signal combinations perforated in tape 304 during the extra cycles of tape transmitter-distributor 302 and when the ciphered signals and the all-marking signal combination perforated in tape 304 have been transmitted by tape transmitter-distributor 316 to relay 323 and the signals have been deciphered and the resulting record produced by a teletypewriter printer 332, tape 327 associated with the cipher signal generator 326 will have been brought into step with tape 51.

The grid of tube 108 is connected through variable resistor 166 and battery 167 from positive to negative polarities to ground and is also connected through condenser 168 and resistor 169 to ground. The constants of the condenser charging circuit comprising resistor 166 and condenser 168 are such that the conductivity of tube 108 will be raised to a level at which relay 106 will operate a little after relay 104 has been operated by tube 107. Sufficient additional time is afforded for the distributor brushes of cipher signal generator 49 to reach the rest segment and be arrested. Upon the operation of relay 106 a conductive path is traced from ground through winding of relay 102, conductors 127 and 126, armature and front contact of relay 106, conductors 124, 123 and 122 to contacts 109. A path is also traced from conductor 124 through conductor 136 and the upper front contact and armature of relay 101, conductor 137 to the back contact associated with the outermost upper armature of relay 103 which is not now engaged by its armature because relay 103 is energized. If the conductive path from battery 128 has been completed through switch 111 and taut tape contacts 109 during the advancement of tape 51 the desired number of steps, the energizing circuit of relay 102 will be completed and the relay will become energized to restart tape transmitter-distributor 41 and to release relays 103, 104 and 106. By virtue of the provision of relay 106 to be operated after relay 104 has operated, the restarting of tape transmitter-distributor 41, in the event that a loop of tape 42 is formed of sufficient magnitude to close contacts 109, is delayed until the synchronizing relay circuit has operated through its full cycle. It is thereby assured that tape 51 will be advanced a predetermined number of steps to correspond with the number of extra cycles imparted to printing reperforator 302. In this way, tape transmitter-distributor 41 cannot be restarted while distributor 50 is in any condition but that of rest, and the reception of signals by printing reperforator 302 will not begin while the distributor of the reperforator is in any condition but that of rest.

The local test key 203 in Fig. 2 provides for testing the synchronizing relay circuit by locally generated signals when no signals are being received by radio receiver 201. This is accomplished by moving the operating handle from the right-hand to the left-hand side to spread the left-hand contact actuators and to release the right-hand contact actuators. When this is done the operating winding of receiving relay 206 is disconnected

from the conductors 202 and 208 over which radio receiver 201 delivers signals, and these conductors are connected together. Conductor 284 is disconnected from the continuous ring of the distributor 317 of tape transmitter-distributor 316 in Fig. 3 and is connected instead to negative battery 277. Conductor 287 is disconnected from the potential divider comprising batteries 288 and 289 and resistors 291 and 292 and is connected instead to positive battery 296. These polarities will hold relay 323 in Fig. 3 on its marking contact if plug 293 is connected in jack 286.

Marking and spacing contact conductors 376 and 378 of tape transmitter-distributor 316 which extend into Fig. 2 as conductors 276 and 278 remain connected to negative and positive batteries 277 and 279, respectively, and conductor 281 from the continuous ring of distributor 317, connecting through the upper left-hand break contacts of timing test key 232 and conductor 282, becomes connected to one terminal of the operating winding of relay 206 and the other terminal becomes connected to the potential divider comprising batteries 288 and 289 and resistors 291 and 292. Relay 206 is thus made responsive to signals generated by tape transmitter-distributor 316. A tape containing a test sentence may be placed in transmitter-distributor 316 and any time that transmitter-distributor 316 is stopped, as by the opening of its taut tape contacts or by opening of the manually operable switch in the energizing circuit of its start magnet, the synchronizing relay circuit in Fig. 2 will go into operation and will produce extra cycles of printing reperforator 302. During the response of the printing reperforator to the signals contained in the test sentence the orientation range limit of the selector mechanism of the reperforator may be determined and the optimum orientation adjustment may be made. Also, the condenser charging circuit comprising condensers 238 and 239, resistor 242 and battery 243 may be adjusted to provide the desired number of extra cycles of the printing reperforator after signal transmission from tape transmitter-distributor 316 is terminated.

Timing test key 232 is used for establishing conditions under which variable resistors 271 and 272 in the biasing circuits of relays 247 and 263 may be adjusted to provide the desired delay in the operation of each of these relays. These adjustments are made with the local test key 203 operated to the test condition, whereby tape transmitter-distributor 316 is connected to the operating winding of receiving relay 206 but the tape transmitter-distributor is not set in operation. The desired adjustment of relay 247 is made with the actuator of timing test key 232 operated to the left to open the lower left-hand and upper left-hand break contacts and to close the upper left-hand make contacts. The lower left-hand break contacts open the energizing circuit for the relay 217 and key 229 should be open so that relay 217 will be released and the synchronizing relay circuit will be conditioned to operate under the control of contacts 312 in the printing reperforator 302. At the upper left-hand break contacts the operating winding of relay 206 is disconnected from the continuous ring of tape transmitter-distributor 316 and at the upper make contacts it is connected to positive battery 233. This battery provides the same polarity as that which the spacing contacts of tape transmitter-distributor 316 are arranged to supply and accordingly relay 206 is operated to a steady spacing condition. This causes selector magnet 301 of tape transmitter-distributor 302 to be released and it remains released except for the artificial stop pulse initiated in each cycle by relay 253 and terminated by relay 247.

One of the frequently used signaling speeds is 368 characters per minute and it will be assumed that printing reperforator 302 is geared to operate in response to signals received at this speed. The printing reperforator feeds tape 304 a distance of $\frac{1}{10}$ inch for each cycle of the reperforator and accordingly in one minute will feed 36.8 inches of tape. The driving mechanism of the printing reperforator is arranged to drive this recorder at a substantially higher speed than 368 operations per minute if no stop signals should be received, but the stop signal causes the printing reperforator to be arrested for an interval between each two code combinations received and thus holds the operating speed down to 368 operations per minute. If the stop signals should be shorter than normal length, the printing reperforator will be held at rest for a shorter interval of time and accordingly it will perform an increased number of operations per minute. As previously stated, relay 247 should be adjusted to operate away from its left-hand contact to terminate the artificial stop impulse an instant before the normal start pulse should be received and the beginning of a normal start pulse coincides with the end of the true or normal stop pulse. With relay 247 so adjusted the speed of operation of printing reperforator 302 will be higher than the normal signal receiving speed because relay 206 is in the steady-spacing condition and the release of the distributor of printing reperforator 302 is effected by operation of relay 247, representing termination of the artificial stop pulse.

The preferred practice is to adjust variable resistor 271 so that in an interval of one minute printing reperforator 302 feeds 37.8 inches of tape, which represents 378 operations per minute. At this speed of operation each cycle of printing reperforator 302 including the stop time occupies approximately .159 second. At the normal receiving speed of 368 operations per minute each operation including the stop time occupies approximately .163 second. From this it is apparent that relay 247 has been adjusted to operate away from its left-hand contact and terminate the artificial stop pulse approximately .004 second earlier than the normal termination of the true stop pulse which coincides with the initiation of the start pulse. During the making of this adjustment the artificial start pulse initiated by relay 213 upon operation of relay 263 to its right-hand contact is masked by the steady-spacing condition of relay 206 so that it has no influence on printing reperforator 302 and does not affect the adjustment of relay 247.

The next adjustment to be made is that of relay 263. This adjustment is made with key 232 operated on its right-hand side to open the single-pair of break contacts, the left-hand contacts being restored to normal. With the left-hand contacts restored to normal, marking battery is reconnected to the operating winding of relay 206 through the upper left-hand break contacts of key 232 so that the relay is held in the steady-marking condition. Thus the only spacing impulses transmitted to printing reperforator 302 will be those representing the artificial start pulse, and the artificial stop pulse will be masked by the steady-marking condition of relay 206. As previously stated, relay 263 is to be adjusted so

that the artificial start pulse is introduced after the time at which the beginning of a normal or true start pulse should be received. The effect of operation of printing reperforator **302** under the control of the artificial start pulse is to increase the stop time of the distributor in the printing reperforator beyond its normal length and accordingly the printing reperforator will perform less than the normal number of operations per minute. With timing test key operated to the right, the energizing circuit of relay **217** is interrupted at the right-hand break contacts of the key so that the synchronizing relay circuit will operate continuously in repeated cycles under the control of contacts **312**. However, in order to start printing reperforator **302** it is necessary to operate key **232** to the left momentarily to connect spacing battery to relay **206** so as to transmit a start pulse to selector magnet **301**. Key **232** is immediately reoperated to and left in its right-hand position and variable resistor **272** in the biasing circuit of relay **263** is adjusted so that in an interval of one minute printing reperforator feeds 35.8 inches of tape which represents 358 operations. At this speed each operation or cycle of printing reperforator **302** occupies approximately .167 second. The difference between this cyclic time and the normal signal receiving cyclic time of .163 second is .004 second. In this way the artificial start pulse has been timed to occur about the same interval after the time at which a normal or true start pulse should occur as the interval of occurrence of the termination of the artificial stop pulse before the coinciding end of a true stop pulse and beginning of a true start pulse.

As previously set forth, the operation of relay **259** occurs about the middle of the true start pulse interval to restore relays **252** and **253**, which in turn restore relays **247** and **263**, and the latter relay restores relays **213** and **216**, the former of which ends the artificial start pulse. With the beginning of the artificial start pulse preferably timed to occur .004 second after the time for occurrence of the beginning of the true start pulse, as described in the preceding paragraph, it will be apparent that the artificial start pulse is considerably shorter than the true start pulse. Since the artificial start pulse is generated locally, and is directly and immediately effective upon the selector magnet **301**, it need be only long enough to cause the selector magnet to release its armature and thereby to release the receiving distributor shaft **306** of the reperforator **302**.

With these adjustments made, keys **203** and **232** restored to normal, and the apparatus in condition to receive signals, the synchronizing relay circuit will afford an interval of approximately .008 second throughout which the time of occurrence of the beginning of a true start pulse may vary and if the true start pulse occurs within this interval printing reperforator **302** will be started in response thereto as if the synchronizing relay circuit were not present.

Although a specific embodiment of the invention has been illustrated in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiment but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, and means for locally generating and impressing on said receiving device start and stop impulses in substantial synchronism with the corresponding impulses of received signals.

2. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device a stop impulse during at least a part of the stop impulse interval of a received signal, and means for locally generating and impressing on said receiving device a start impulse during at least a part of the start impulse interval of a received signal.

3. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for localy generating and impressing on said receiving device start and stop impulses in substantial synchronism with the corresponding impulses of received signals, and means operable by said receiving device in each cycle of operation thereof for activating said local start and stop impulse generating means.

4. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, normally inoperative means for locally generating and impressing on said receiving device start and stop impulses, means responsive to the reception of telegraph signals for qualifying said local start and stop impulse generating means to be activated, and means operable by said receiving device in each cycle of operation thereof for activating said local start and stop impulse generating means whereby to cause said means to generate said impulses in substantial synchronism with the corresponding impulses of received signals.

5. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, normally inoperative means for locally generating and impressing on said receiving device start and stop impulses, means responsive to the reception of telegraph signals for qualifying said local start and stop impulse generating means to be activated, means for delaying the response of said qualifying means until a plurality of telegraph signals have been received, and means operable by said receiving device in each cycle of operation thereof for activating said local start and stop impulse generating means whereby to cause said means to generate said impulses in substantial synchronism with the corresponding impulses of received signals.

6. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device start and stop impulses in substantial synchronism with the corresponding impulses of received signals, and means operable a predetermined interval after signal reception ceases and during which interval said receiving device operates under the control of said locally generated start and stop impulses for disabling said local start and stop impulse generating means.

7. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for repeating received signals including

tioned storage type signal generator to operate a number of cycles after signal reception ceases, means for causing said first-mentioned storage type signal generator to operate a like number of cycles after operation of said message signal generator ceases, means for suppressing operation of said first-mentioned combining means during said cycles of said first-mentioned storage type signal generator, and means for estopping further operation of said message signal generator until after completion of said cycles of operation of said first-mentioned storage type signal generator.

16. In a telegraph system, a start-stop telegraph signal generator, a storage type signal generator operable conjointly with said start-stop telegraph signal generator to produce ciphered signals, a tape perforating receiver operable in start-stop manner for receiving said ciphered signals, means local to said receiver for generating a predetermined number of start and stop impulses to cause said tape perforating receiver to operate for a like number of cycles when signal reception ceases, and to produce a like number of signal perforations in said tape in addition to those representing said ciphered signals, a tape transmitter controllable by said tape, a storage type signal generator operable conjointly with said tape transmitter in response to all of the signals in said tape for deciphering said ciphered signals, means local to said first-mentioned storage type signal generator for causing a like number of cyclic operations thereof upon cessation of conjoint operation with said start-stop telegraph signal generator whereby to keep said first-mentioned storage type signal generator in phase with said second-mentioned storage type signal generator, and means for suppressing signal transmission during the performance of said like number of cyclic operations.

17. In a telegraph system, a transmitter including a storage type signal generator normally operable in cycles initiated by start impulses and terminated by stop impulses, means for applying start and stop impulses to said generator, a transmitting relay controlled by said generator, means for disabling said start and stop impulse applying means, means responsive to disablement of said start and stop impulse applying means for initiating continuous operation of said generator and for rendering said relay unresponsive to said generator, and means for terminating operation of said generator after a predetermined interval of operation thereof.

18. In a telegraph system, a transmitter including a storage type signal generator having a sequence of codes adapted to be presented in signal generating position in succession, said generator being normally operable in cycles initiated by start impulses and terminated by stop impulses, means for applying start and stop impulses to said generator, a transmitting relay controlled by said generator, means for disabling said start and stop impulse applying means, means responsive to disablement of said start and stop impulse applying means for initiating continuous operation of said generator whereby to cause a plurality of said stored codes to be advanced past said signal generating position and for rendering said relay unresponsive to said generator, and means for terminating operation of said generator after a predetermined interval.

19. In a telegraph system, a transmitter including a storage type signal generator normally operable in cycles initiated by start impulses and terminated by stop impulses, means for applying start and stop impulses to said generator, a transmitting relay controlled by said generator, means for disabling said start and stop impulse applying means, means responsive to disablement of said start and stop impulse applying means for initiating continuous operation of said generator and for rendering said relay unresponsive to said generator, timing means activated concomitantly with initiation of continuous operation of said generator, and means controlled by said timing means upon timing a predetermined interval for stopping said generator.

20. In a telegraph system, a transmitter including a storage type signal generator normally operable in cycles initiated by start impulses and terminated by stop impulses, means for applying start and stop impulses to said generator, a transmitting relay controlled by said generator, means for disabling said start and stop impulse applying means, means responsive to disablement of said start and stop impulse applying means for initiating continuous operation of said generator and for rendering said relay unresponsive to said generator, means for stopping said generator after a predetermined interval of operation thereof, and means for estopping reactivation of said start and stop impulse applying means until after the stopping of said generator.

21. In a telegraph system, a start-stop telegraph transmitter, a start-stop receiver, a communication channel over which said receiver may receive start-stop signals from said transmitter, means local to said receiver for generating and impressing start and stop impulses on said receiver, and means for causing said last-mentioned means to generate said impulses in substantial synchronism with the start and stop impulses of received signals.

22. In a telegraph system, a transmitter for transmitting code combinations each comprising a start impulse, a plurality of significant impulses and a stop impulse, a start-stop receiver for receiving said code combinations, means local to said receiver for generating and impressing start and stop impulses on said receiver, and means for causing said last-mentioned means to generate said impulses in the interval between the last significant impulse of each received code combination and the first significant impulse of the succeeding code combination.

23. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, means responsive to start impulses of received signals for starting said device, and means for locally generating and impressing start impulses on said starting means in substantial synchronism with the corresponding impulses of received signals.

24. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, means operable in response to received start impulses for starting said device, and means for operating said starting means in the absence of received start impulses.

25. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, means responsive to start impulses of received signals for starting said device, and means for locally generating and impressing a start impulse on said starting means during at least a part of the start impulse interval of received signals.

26. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by

the start and stop impulses thereof to said receiving device, normally disabled means for locally generating and impressing on said receiving device start and stop impulses, means responsive to said repeating means for qualifying said local start and stop pulse generating means to be activated, means operable by said receiving device in each cycle of operation thereof for activating said local start and stop pulse generating means, means for disabling said local start and stop pulse generating means, and timing means for operating said disabling means a predetermined interval after signal reception by said repeating means ceases.

8. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device start and stop impulses, means for impressing received telegraph signals including the start and stop impulses thereof on said receiving device, and means for limiting to a predetermined number the cycles of said receiving device in response exclusively to said locally generated start and stop impulses.

9. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for impressing received telegraph signals including the start and stop impulses thereof on said receiving device, and means for locally generating and impressing on said receiving device start impulses beginning and ending within the intervals of correctly received full length start impulses and stop impulses beginning and ending within the interval of correctly received full length stop impulses whereby correctly received full length start and stop impulses mask the corresponding locally generated impulses.

10. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for impressing received telegraph signals including the start and stop impulses thereof on said receiving device, means for locally generating and impressing stop impulses on said receiving device, means for terminating said locally generated stop impulses in advance of the time for occurrence of the coinciding termination of the stop impulse and initiation of the start impulse of correctly received normal length signals, and means for locally generating and impressing start impulses on said receiving device after the time for occurrence of the coinciding termination of the stop impulse and initiation of the start impulse of correctly received normal length signals whereby said receiving device is controllable primarily by received stop and start impulses and secondarily by locally generated stop and start impulses.

11. In a telegraph system, a start-stop transmitter, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating start and stop impulses to cause said receiving device to operate a predetermined number of cycles after signal reception ceases, means for causing said transmitter to operate a like number of cycles after message transmission ceases, and means for suppressing transmission of any impulses by said transmitter during said cycles.

12. In a telegraph system, a start-stop transmitter, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means local to said receiving device for generating start and stop impulses to cause said receiving device to operate a predetermined number of cycles after signal reception ceases, means for causing said transmitter to operate a like number of cycles after pressing transmission of any impulses by said transmitter during said cycles, and means varying said number of cycles of said receiving device and of said transmitter.

13. In a telegraph system, a start-stop transmitter, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means local to said receiving device for generating start and stop impulses to cause said receiving device to operate a predetermined number of cycles after signal reception ceases, means for causing said transmitter to operate a like number of cycles after message transmission ceases, means for suppressing transmission of any impulses by said transmitter during said cycles, and means for precluding resumption of message transmission until after completion of said predetermined number of cycles by said transmitter.

14. In a telegraph system, a start-stop message signal generator, a start-stop storage type of signal generator having a sequence of non-message codes in storage, a communication channel, means for interactively combining signals generated by said message signal generator and signals generated by said storage type signal generator and for impressing the resulting signals on said channel, means operable in cycles initiated by start impulses and terminated by stop impulses for receiving said signals from said channel, a storage type of signal generator having a sequence of codes in storage identical with said first-mentiond sequence of codes, means for causing the signals received by said receiving means to be interactively combined with signals generated by said second-mentioned storage type signal generator whereby to derive the original message signals, means local to said receiving means for generating start and stop impulses to cause said receiving means and said second-mentioned storage type signal generator to operate a number of cycles after signal reception ceases, means for causing said first-mentioned storage type signal generator to operate a like number of cycles after operation of said message signal generator ceases, and means for suppressing operation of said first-mentioned combining means during said cycles of said first-mentioned storage type signal generator.

15. In a telegraph system, a start-stop message signal generator, a start-stop storage type of signal generator having a sequence of non-message codes in storage, a communication channel, means for interactively combining signals generated by said message signal generator and signals generated by said storage type signal generator and for impressing the resulting signals on said channel, means operable in cycles initiated by start impulses and terminated by stop impulses for receiving said signals from said channel, a storage type of signal generator having a sequence of codes in storage identical with said first-mentioned sequence of codes, means for causing the signals received by said receiving means to be interactively combined with signals generated by said second-mentioned storage type signal generator whereby to derive the original message signals, means local to said receiving means for generating start and stop impulses to cause said receiving means and said second-men-

start impulses, means responsive to start impulses of received signals for starting said device, and means for locally generating and impressing start impulses on said starting means in substantial synchronism with corresponding impulses of received signals and of sufficient duration to effect the operation of said starting means.

27. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, means for locally generating and impressing on said receiving device start impulses in substantial synchronism with the corresponding impulses of received signals, and means for disabling said start impulse generating means a predetermined interval after cessation of signal reception.

28. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, means for locally generating and impressing on said receiving device start impulses in substantial synchronism with the corresponding impulses of received signals, and means for disabling said start impulse generating means upon the generation thereby of a predetermined number of said start impulses after cessation of signal reception.

29. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses received incidental to accompanying code impulses, start means for initiating cycles of said receiving device in the absence of received start impulses, and means for limiting the number of consecutive operations of said start means during a period of time in which no impulses are received.

30. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, a signal responsive relay for repeating received signals including start impulses to said receiving device, and a relay for locally generating and impressing on said receiving device start impulses in substantial synchronism with the corresponding impulses of received signals.

31. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses, a signal responsive relay for repeating received signals including start impulses to said receiving device, a relay for locally generating and impressing the start impulses on said receiving device, and means for operating said last-mentioned relay in substantial synchronism with the start impulses of received signals.

32. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device start and stop impulses, and timing means for causing said start and stop impulse generating means to be activated in substantial synchronism with the corresponding impulses of received signals.

33. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device start and stop impulses, and means operable a predetermined interval after the beginning of any received or locally generated start impulse for activating said start and stop impulse generating means.

34. In a telegraph system, a start-stop signal receiving device operable in cycles initiated by start impulses and terminated by stop impulses, means for locally generating and impressing on said receiving device start and stop impulses, means operable a predetermined interval after the beginning of any received or locally generated start impulse for activating said start and stop impulse generating means, and means operable after a predetermined number of successive cycles of said receiving device initiated exclusively by said local start impulse generating means for disabling said activating means.

35. In a telegraph signal repeating device, an incoming signaling path, an outgoing signaling path, a receiving relay associated with said incoming path and adapted to cause received signals to be impressed on said outgoing path, and means for impressing a marking signal on said outgoing path at predetermined intervals independently of whether said receiving relay responds to a corresponding marking signal.

36. In a telegraph signal repeating device, an incoming signaling path, an outgoing signaling path, a receiving relay associated with said incoming signaling path and adapted to cause received signals to be impressed on said outgoing path, and means for impressing a marking signal on said outgoing path in timed relation to signals received by said receiving relay but independently of whether said receiving relay concurrently responds to a corresponding marking signal.

37. In a start-stop telegraph signal repeating device, an incoming signaling path, an outgoing signaling path, a receiving relay responsive to start-stop telegraph signals arriving on said incoming path and adapted to cause said signals to be impressed on said outgoing path, and means for impressing a stop signal on said outgoing path, a predetermined interval after a start signal whether or not said receiving relay receives a stop signal.

38. In a start-stop telegraph signal repeating device, an incoming signaling path, an outgoing signaling path, a receiving relay responsive to start-stop telegraph signals arriving over said incoming path and adapted to cause said signals to be impressed on said outgoing path, and means for impressing a stop signal on said outgoing path, a predetermined interval after response of said receiving relay to a start signal whether or not said receiving relay receives a stop signal to be repeated to said outgoing path.

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