

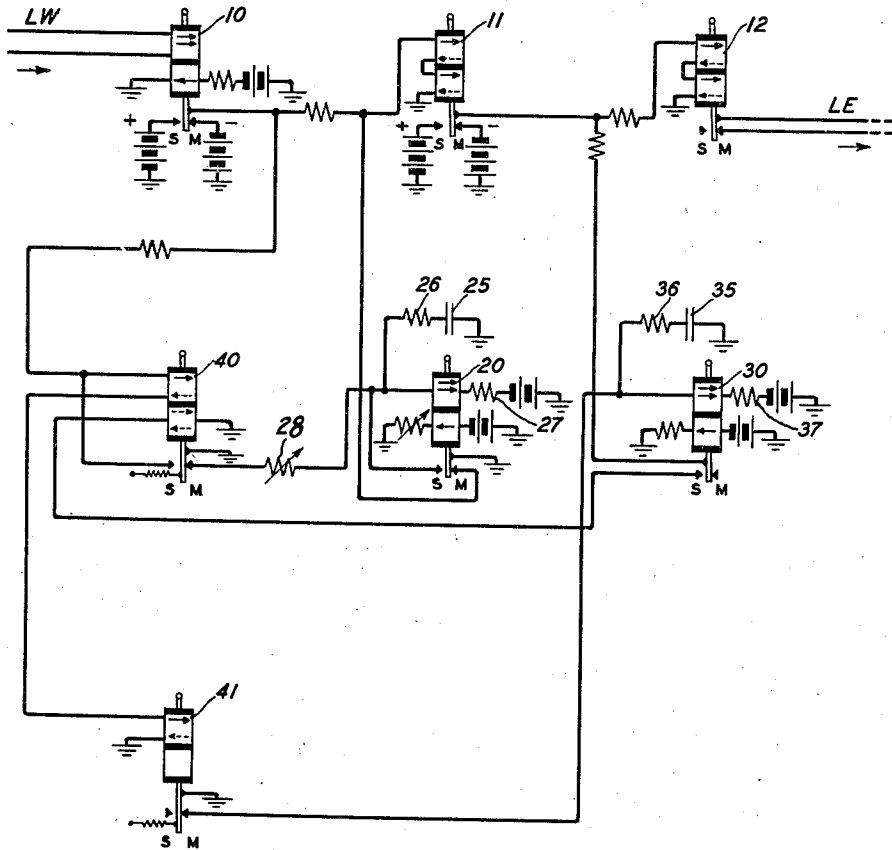
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REGENERATIVE TELEGRAPH REPEATER

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REGENERATIVE TELEGRAPH REPEATER

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This invention relates to start-stop regenerative telegraph repeaters, and more particularly to repeaters of the type in which the timing is accomplished by vibrating relay means.

In repeaters of this type, vibrating relay circuits are used as timing means in lieu of rotating distributors. One vibrating relay circuit is timed to vibrate once for each impulse of a start-stop signal series, and another relay is timed to vibrate once only for each start-stop series to stop the fast relay circuit at the end of each series. A circuit of this type has been disclosed in United States Patent 1,771,445, issued to Parker-Vernam on July 29, 1930. A different type of circuit serving a similar purpose has been disclosed in U. S. Patent 1,771,446, issued to Parker-Vernam on July 29, 1930.

It is an object of the invention to provide a regenerative repeater circuit of the non-rotary type, just described, in which the slow relay circuit is given a wide margin of operation, thereby insuring accuracy of operation with less delicate adjustment of the relay circuit.

It is a further object of the invention to provide a regenerative repeater circuit in which the vibrating relay circuit for timing the individual impulses of a signal series produces short distinct impulses and thereby permits simplification of the control circuit for the repeating relays.

In accordance with the invention, a stop circuit is under control of the slow relay circuit for stopping the operations of the fast relay circuit at the end of a signal series representing a character. The stop circuit is connected to also be under the control of the transmission circuit of the repeater, so that it will be effective in stopping the fast relay circuit only when signal impulses of the same characteristics as the stop impulse are passing through the transmission circuit. The advantage of this arrangement is that the slow relay circuit is permitted to return to its normal position for stopping the fast relay circuit any time after the penultimate impulse has been timed, rather than during the stop impulse only, as in prior art systems, and thus is given a greater margin for returning to normal position. When the penultimate signal impulse of a series is of the same characteristic as the stop impulse, which usually is a marking impulse, the fast relay circuit will be stopped immediately upon return to normal of the slow relay circuit, which return may occur during the latter part of the penultimate impulse. It is evident that in this case, there is no transition from one signal characteristic to another between the last two

impulses, and that, therefore, there will be no need of a timing operation by the fast relay circuit after the penultimate impulse has been timed. On the other hand, when the penultimate impulse is of opposite characteristic to that of the stop impulse, namely, a spacing impulse, the stop circuit will be ineffective after the return of the slow relay circuit during the penultimate impulse and the fast relay circuit thus will be able to time properly also the stop impulse. When the transmission relays have been set for the stop signal, the stop circuit is rendered effective and the fast relay circuit will be stopped during the stop impulse.

In accordance with another feature of the invention the repeating operations are timed by means of a vibrating relay circuit which is highly biased in its operation and which consequently will remain in one of its alternate positions for a comparatively short portion of its operating cycle. This short interval is utilized to permit a transition operation by the repeating relays and the intervening longer periods are utilized for accurately spacing the transition operations of the repeating device.

The invention will now be described in connection with a specific embodiment comprising a telegraph repeating system such as is illustrated in the accompanying drawing, to which reference will be made in the following description.

A number of arrows have been applied to the various relay windings in the drawing to make understanding of the operations easier. The arrows which are drawn in full lines indicate the direction in which the particular winding tends to operate the relay armature under the particular circuit conditions shown in the drawing, whereas the arrows shown in dotted lines indicate the direction in which the winding will operate the armature under alternate conditions. A double arrow indicates that the winding is more strongly energized than the associated winding marked with a single arrow and thus indicates that the former winding is capable of preventing operation of the relay by the latter winding.

The regenerative repeating system is shown connected between an incoming line circuit LW and an outgoing line circuit LE. Signals incoming over the line west LW operate the receiving relay 10 which operates the retransmitting relay 11 which in turn operates the line relay 12; line relay 12 impresses the repeated signals upon the line east LE.

The timing circuit comprises the code element

timing relay 20, the character timing relay 30, and the starting relays 40 and 41. During reception of each start-stop signal series, relay 20 oscillates in synchronism with the impulses incoming over line west to time each response of relay 11. The oscillations of relay 20 are started by relay 40 in response to the start impulse of each incoming signal series. During each signal series relay 30 makes one oscillation of a duration slightly less than that of the complete signal series. The oscillation of relay 30 is started by relay 41 in response to the start impulse. On completing its oscillation near the end of the signal series relay 30 stops the oscillations of relay 20 and therefore stops further operation of the entire repeating system until the next start impulse arrives.

In the specific embodiment shown in the drawing the receiving relay 10 has a permanent biasing winding and has an operating winding responsive to opening and closing of the line west. The line relay 12 transmits signals into the line east by opening and closing the line. The sources of current are assumed to be located at the distant ends of both line circuits. In case it should be desired to retransmit the signals into line east as polar signals, relay 12 may be omitted and one line conductor of the line east connected to the armature of retransmitting relay 11.

Relay 20 normally connects ground through its marking contact to short-circuit the operating windings of relay 11, thereby preventing response by relay 11 to operations of relay 10. During signaling, relay 20 oscillates in synchronism with signals incoming over line west. For a short interval during each oscillation relay 20 operates to spacing, thereby removing the short circuit for relay 11 and permitting this relay to respond either to marking or spacing potential at relay 10. After relay 11 has assumed its position its winding is again short-circuited and the short-circuiting current tends to hold the relay in position without chattering. The relay 11 may be of a type which has sufficient remanent magnetism to normally hold the relay firmly against its contacts in either position; however, if desired, one of the operating windings may be disconnected from the operating circuit and connected through a suitable resistance to the armature of the relay for the purpose of self-locking in both positions as is well known.

For the purpose of controlling the timing circuits a set of starting relays 40 and 41 are provided. In their normal position these relays apply ground to the operating windings of the timing relays 20 and 30, respectively, thereby locking the latter relays in their marking position and preventing them from oscillating. When the receiving relay 10, in response to a start impulse, operates to spacing, relays 40 and 41 operate to spacing, thereby opening the locking circuits for relays 20 and 30. In spacing position, relay 40 short-circuits the operating windings of relays 40 and 41 which remain in spacing position in response to suitable biasing means, such as a light spring attached to the armature.

Relays 20 and 30 then commence their cyclic operations, relay 20 with a frequency such that it will complete a cycle once for each incoming impulse of a signal series representing a character and relay 30 with a frequency such that it will complete one cycle in a period slightly shorter than the duration of a complete signal series.

The timing relay 20 has fixed biasing means such as a biasing winding continuously energized

and tending to operate the armature to spacing. The upper operating winding is normally energized over the marking contact of relay 40; the condenser 25 and resistance 26 are short-circuited in this circuit. When relay 40 opens its marking contact, the condenser 25 gradually becomes charged through the operating winding of relay 20 and thus for a time serves to hold this relay to marking. When the charging current has decreased sufficiently, the biasing winding will overcome the operating winding and operate the armature to spacing. At this moment ground at the spacing contact is applied to this circuit the condenser will be quickly discharged and full operating current will be restored in the operating winding and the relay will quickly operate to marking, again permitting condenser 25 to become charged through the operating winding. Under these conditions the armature of relay 20 will continue to oscillate and will be in its spacing position for only a small fraction of its cycle. By proper adjustment of resistance 27 this fraction can be varied and by proper adjustment of condenser 25 and resistance 26 the frequency can be adjusted to coincide with the impulse frequency of the signals.

The orienting resistance 28 serves to normally establish a certain charge on condenser 25 so that the first operation to spacing by relay 20 will take place after a given interval upon opening of the marking contact of relay 40 or in other words, upon the arrival of a start impulse over line west. By proper adjustment of resistance 28 the short spacing periods of relay 20 may thus be oriented with respect to incoming signals in such a manner that relay 11 will be permitted to respond to relay 10 only during that part of each incoming impulse which has least distortion.

Timing relay 30 also has a permanent biasing winding and its operating winding is normally energized over the marking contact of relay 41; condenser 35 and resistance 36 are normally short-circuited in this circuit. When relay 41 responds to a start impulse, condenser 35 begins to charge through the operating winding of relay 30, thereby holding the relay to marking. Condenser 35 and resistances 36 and 37 may be so adjusted that the operating current will not be sufficiently reduced to permit the biasing winding to operate the armature to spacing until about the time the last character impulse has been completed and the stop impulse commences. At this time relay 30 goes to spacing and completes a circuit from the armature of relay 11 to the lower winding of relay 40. If at this time relay 11 happens to be in spacing position relay 40 will be held in spacing position. However, if relay 11 should be in marking position relay 40 will be operated to marking and will stop the cyclic operations of relay 20. Relay 11 being in marking position, relay 10 must also be in marking position at this time so that, when relay 40 operates to marking, relay 41 will be operated to marking and will stop the oscillations of relay 30.

Assuming the arrival of a start-stop signal series over the line west, the operations of the system will be as follows:

Line west and line east normally carry current and all the relays will normally be in the positions shown in the drawing. When a start impulse arrives, line west will be currentless and relay 10 operates to spacing, closing a circuit from battery at its spacing contact through the upper windings of relays 40 and 41, thereby operating these relays to spacing; these windings will now

be short-circuited at the spacing contact of relay 40 and the armatures will be held to spacing by the biasing springs.

When the marking contact of relay 40 opens, condenser 25 begins to charge through the upper operating winding of relay 20; similarly when the marking contact of relay 41 opens, condenser 35 begins to charge through the upper operating winding of relay 30. Due to the orienting adjustment of resistance 28 condenser 25 already had a certain charge, so that, after a comparatively short time, the charging current will be reduced to a value at which the biasing winding will operate relay 20 to spacing. This will occur shortly before the arrival of the peak or center of the start impulse, at which time relay 10 is firmly positioned in response thereto. When relay 20 goes to spacing the short circuit at its marking contact is removed from the windings of relay 11 which now is given a short interval in which to respond to the position of relay 10 and operate to spacing. Immediately after the passing of the peak of the start impulse, relay 20 will return to its marking position, thereby effectively preventing relay 11 from being disturbed by the next operation of relay 10. Relay 20, as previously explained, receives full operating current in spacing position and, depending upon the value of resistance 27, is quickly returned to marking where it will be held by the charging current from condenser 25.

Relay 11 in its spacing position causes relay 12 to operate to spacing and thus to send a start impulse out over line east by opening of the line.

When the first character impulse arrives over line west relay 10 responds thereto. Due to the short circuit about their windings, relays 40 and 41 remain unaffected by operations of relay 10.

By the time the peak of the first character impulse arrives, relay 20 will again operate to spacing and back to marking for a short instant, permitting relay 11 to respond to the position of relay 10 just at the time when relay 10 can be expected to be firmly in position. Relay 11 operates relay 12 correspondingly and a corresponding character impulse will be impressed upon line east.

For each of the five character impulses of the signal series the operations will be repeated as just described for the first character impulse.

The last impulse, or stop impulse, of each signal series being a marking impulse, it is evident that in those instances where the last, or fifth, character impulse is also a marking impulse, all the transmission relays 10, 11 and 12 will perform no transition between these two impulses, so that it will be necessary only to time the operations in response to the fifth impulse. This fact is taken advantage of to provide a greater margin for the restoration of relay 30 to marking position near the end of a signaling series, thereby requiring less accuracy in the adjustment of relay 30.

Relay 30 has been held to marking by charging current from condenser 35 until some time after the timing operation of relay 20 in connection with the fifth character impulse; at this moment the charging current is sufficiently reduced to permit the biasing winding to operate relay 30 to spacing. If at this moment relay 11 is in marking position, whether this be due to the fifth character impulse or to the stop impulse, negative battery will be applied over the marking contact of relay 11 and spacing contact of relay 30 through the lower winding of relay 40 to operate relay 40 to its marking position. Relay 40 now

stops the oscillations of relay 20 so that relay 11 will be prevented from operating until the next start impulse has been received over line west. The marking potential at relay 10 now operates relay 41 to marking, which in turn causes relay 30 to return to marking, thereby restoring the circuit to normal in readiness for reception of the next start impulse.

However, if at the time relay 30 was ready for operation to spacing transmitting relay 11 had been in spacing position due to the reception of the fifth character impulse as a spacing impulse, spacing potential would have been applied over the contacts of relays 11 and 30 to the lower winding of relay 40, thereby holding relay 40 in spacing position.

When now the stop impulse arrives over line west to operate relay 10 to marking, relay 20 will perform its cyclic operation in the same manner as in timing the preceding impulse of this series, and relay 11 will be allotted a short interval in which to respond to the position of relay 10 and operate to marking, whereupon relay 20 returns to marking position commencing a new cycle. Relay 11 operates relay 12 and the stop impulse is transmitted over line east.

Relay 11 now being in marking position, it will apply marking potential over the spacing contacts of relay 30 to the lower winding of relay 40 which operates and prevents further operations of relay 20. Relay 10 being in marking position, relay 41 will be restored to marking and will in turn operate relay 30 to marking, thereby reconditioning the circuit for the next signal series.

Reference is made to my application for U. S. patent Serial No. 153,878, filed on even date herewith and relating to the same subject-matter as the present application.

What is claimed is:

1. A start-stop telegraph repeater for retransmission of successive signal series containing the same number of impulses comprising retransmitting relay means including fast timing means for controlling the frequency of retransmission of impulses, control relay means including slow timing means for stopping the retransmission of impulses near the end of each series, and circuit means controlled by said retransmitting relay means for preventing a premature stopping action by said control relay means by delaying the said stopping action till the last impulse of a series whenever the last two impulses of the series are of opposite characteristics.

2. A start-stop telegraph repeater for retransmission of successive signal series containing the same number of impulses comprising retransmitting relay means including fast timing means for controlling the frequency of retransmission of impulses, control relay means including slow timing means for stopping the retransmission of impulses during either of the last two impulses of each series, and circuit means controlled by said retransmitting relay means for preventing stopping action by said control relay means during the next to the last impulse whenever the last two impulses of the series are of opposite characteristics.

3. A start-stop telegraph repeater for retransmission of successive signal series containing the same number of impulses comprising retransmitting relay means including fast timing means for controlling the frequency of retransmission of impulses and capable of stopping retransmission at any impulse of each series, control relay means including slow timing means for preventing said

stopping action until near the end of each series, and circuit means including contacts of said retransmitting relay means for preventing said stopping action until the retransmission of the last impulse of the series whenever the last two impulses of the series are of opposite characteristics.

4. A start-stop telegraph repeater for retransmission of successive signal series containing the same number of impulses comprising retransmitting relay means including fast timing means for accurately timing the transition actions by said retransmitting relay means between successive impulses, control relay means including slow timing means for restoring the repeater to top condition during either of the last two impulses of a series, and circuit means including pole-changing contacts on said retransmitting relay means for delaying the restoring action until after the last transition action of the series.

5. A start-stop telegraph repeater for retransmission of successive signal series containing the same number of impulses comprising retransmitting relay means including fast timing means for controlling the frequency of retransmission of impulses, control relay means having contacts for, in one position, stopping said fast timing means during the penultimate impulse of each series, and circuit means including pole-changing contacts on said retransmitting relay means and a winding on said control relay means to hold said first contacts in alternate position until the retransmission of the stop impulse each time the penultimate impulse and the stop impulse have dissimilar characteristics.

6. A telegraph repeater for retransmission of start-stop signal series containing a fixed plurality of impulses which comprises retransmitting relay means, fast timing means for timing of individual impulses, series timing means for returning the repeater to rest condition near the end of each signal series, start relay means responsive to incoming start impulses for starting both of said timing means, and a winding on said start relay means connected to contacts on said retransmitting relay means to delay till the stop impulse the said return of the repeater in the case by a premature timing action of said series timing means during a penultimate impulse of characteristics different from the stop impulse.

7. A telegraph repeater for retransmission of start-stop signal series containing a constant plurality of impulses which comprises retransmitting relay means having pole-changing contacts, fast timing means for timing of individual impulses and capable of ceasing its timing operations at any impulse of a series, series timing means for restoring the repeater to stop condition near the end of each series, start relay means responsive to incoming start impulses for starting both of said timing means and an operating winding on said start relay means connected through contacts on said series timing means to said pole-changing contacts to stop said fast timing means during the penultimate or the last impulse of a series depending upon the character of the penultimate impulse.

8. A telegraph repeater for retransmission of start-stop signal series containing a fixed plurality of impulses which comprises retransmitting relay means, fast oscillating timing means for timing of individual impulses started in response to incoming start impulses, series control relay means for stopping said fast timing means during the penultimate impulse of each series, and a

winding on said control relay means controlled by said retransmitting relay means to prevent the stopping of said fast timing means except when said retransmitting relay means is in stop position.

9. A non-rotary regenerative start-stop repeater having an impulse repeating relay, a fast vibrating polar relay having contacts for timing of individual impulses transmitted by said repeating relay, stop circuit means for said fast relay and a slow vibrating polar relay having contacts connected to control said circuit means when returning to normal position near the end of each impulse series for stopping the said fast relay, characterized in this that the slow relay is timed to return to normal during either of the last two impulses of a series, and that the stop circuit means is connected to be controlled by said repeating relay to be effective in stopping said first relay only during an impulse of the same characteristics as the last impulse.

10. A telegraph repeater for retransmission of start-stop signal series which comprises retransmitting relay means having marking and spacing positions and having contacts, timing means for timing each operation by said relay means and started in response to incoming spacing start impulses, control relay means having contacts for stopping the operations of said retransmitting relay means and including timing means for timing the said stopping to occur during the impulse immediately preceding the marking stop impulse of each of several signal series, and a winding on said control relay means connected to the contacts of said retransmitting relay means to delay the said stopping while said retransmitting relay means is in its spacing position.

11. A telegraph repeater for retransmission of signal impulse series including start and stop impulses of different characteristics which comprises retransmitting relay means responsive to incoming signals and having contacts for producing outgoing signals, oscillating relay means of signal impulse frequency for timing each operation of said retransmitting relay means, control relay means having contacts connected to control the starting and stopping of operations of said retransmitting relay means, and having a winding responsive to an incoming impulse of start impulse characteristic for starting said operations and having a second winding responsive to an outgoing impulse of stop impulse characteristic for stopping said operations, and slow timing means for preventing said stopping until the outgoing impulse immediately preceding the stop impulse of an impulse series and for then conditioning said control relay means for said stopping during the said preceding impulse.

12. A start-stop repeating system having a signaling circuit including repeating relay means and further comprising fast timing means for synchronizing the operations of said repeating relay means with the incoming impulses, control relay means responsive to a spacing start impulse in said signaling circuit to start said operations and including circuit means for making said control relay means responsive to subsequent spacing impulses in said signaling circuit for continuing said operations and to marking impulses in said signaling circuit preceding the stop impulse for stopping said operations, and slow timing means included in said circuit means to prevent said control relay means from responding to

any of the impulses between the start impulse and the penultimate impulse of a signal series.

13. A start-stop telegraph repeating system comprising retransmitting relay means in the signaling circuit, fast timing means for timing each operation of said relay means in response to incoming impulses, control relay means having a winding responsive to spacing start impulses in said signaling circuit for starting operations of said fast timing means and having another winding responsive to marking impulses in said signaling circuit for stopping the operations of said fast timing means, and slow timing means connected to prevent said control relay means from accomplishing said stopping actions during the interval between the start impulse and the penultimate impulse of an impulse series.

14. A start-stop telegraph repeating system comprising retransmitting relay means in the signaling circuit, fast timing means for timing each operation of said relay means in response to incoming impulses, control relay means having a winding responsive to spacing start impulses in said signaling circuit for starting with a desired orientation the operations of said fast timing means and having another winding responsive to marking impulses in said signaling circuit for stopping the operations of said fast timing means, and slow timing means connected to prevent said control relay means from accomplishing said stopping and starting actions during the interval between the start impulse and the penultimate impulse of an impulse series.

15. A regenerative start-stop signal repeating system including a signaling circuit and repeating relay means in the signaling circuit, synchronizing means for said relay means and control relay means for starting and stopping said repeating system, said control relay means having contacts and being timed to condition said repeating system for said stopping action before the retransmission of the stop impulses in said signaling circuit and said repeating relay means having contacts for controlling the stopping to take place after the last transition between impulses in each series.

16. A regenerative start-stop signal repeating system including a signaling circuit and repeating relay means in the signaling circuit, synchronizing means for said relay means and control relay means for starting and stopping said repeating system, said control relay means having contacts connected to stop said repeating system during one of the impulses of a signal series, and said repeating relay means having contacts connected to prevent the stopping until the next impulse of the series.

17. A regenerative start-stop signal repeating system including a signaling circuit and repeating relay means in the signaling circuit, synchronizing means for said relay means and control relay means for starting and stopping said repeating system, said control relay means having contacts connected to stop said repeating system before the sending of the stop impulse of a signal series and said repeating relay means having contacts connected to prevent the stopping until the stop impulse of the series.

18. A regenerative telegraph repeater comprising receiving relay means, retransmitting relay means and a timing relay circuit for producing highly biased impulses comprising a polar relay having continuous biasing means for operating the relay into one position, having contact means, and having a winding connected through said

contacts in said one position to a current source for quick operation into the other position, and capacitance means connected to be charged through said winding to hold the relay in said other position for a predetermined time and connected to said contact means to be discharged in said one position, and said repeater further comprising first circuit means for operation of said retransmitting relay means by said receiving relay means in response to incoming signal impulses and second circuit means connecting the contact means of said timing relay circuit to said first circuit means for repeatedly permitting retransmission by said retransmitting relay means only while said contact means is in said one position.

19. A regenerative start-stop telegraph repeater comprising receiving relay means, retransmitting relay means responsive to said receiving relay means, and a timing relay circuit for producing highly biased impulses comprising a polar relay having continuous biasing means for operating the relay into one position, having contact means, and having a winding connected through said contacts in said one position to a current source for quick operation into the other position, and capacitance means connected to be charged through said winding to hold the relay in said other position for a predetermined time and connected to said contact means to be discharged in said one position, said timing relay circuit having its contact means connected to by-pass in its said other position the operating winding of said retransmitting relay means to permit said retransmitting relay to operate only during a short interval of each operating cycle of said relay circuit, said repeater further comprising start relay means operative from normal position in response to said receiving relay means on reception of the start impulse of an incoming start-stop signal series, a second timing circuit capable of oscillating with a cycle period substantially equal to the duration of one start-stop signal series, said start relay means having contacts connected in normal position to lock said timing relay circuit and said second timing circuit, and to release said two timing circuits for cyclic operation at said response to the start impulse said second timing circuit having contacts operated at the end of its cycle and connected to restore to normal said start relay means.

20. A regenerative start-stop telegraph repeater comprising receiving relay means, retransmitting relay means responsive to said receiving relay means, a timing relay circuit for producing highly biased impulses comprising a polar relay having continuous biasing means for operating the relay into one position, having contact means, and having a winding connected through said contacts in said one position to a current source for quick operation into the other position, and capacitance means connected to be charged through said winding to hold the relay in said other position for a predetermined time and connected to said contact means to be discharged in said one position, said timing relay circuit having its contact means connected to by-pass in its said other position the operating winding of said retransmitting relay to permit said retransmitting relay to operate only during a short interval of each operating cycle of said relay circuit, said repeater further comprising start relay means operative from normal position in response to said receiving relay means on reception of the start impulses of an incoming

start-stop signal series, a second timing relay circuit capable of oscillating with a cycle period substantially equal to the duration of each start-stop signal series, said start relay means having
5 contacts connected in normal position to lock said two timing relay circuits, and to release said two timing circuits for cyclical operation at said response to the start impulse, said second timing circuit having contacts operated at the end

of its cycle and connected to restore to normal said start relay means, adjustable resistance connected between said timing relay circuit and contacts of said start relay means to establish a normal charge on the capacitance means of said first
5 timing relay circuit to orient the cyclic operations of said timing relay circuit relative to the individual impulses of an incoming signal series.

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