

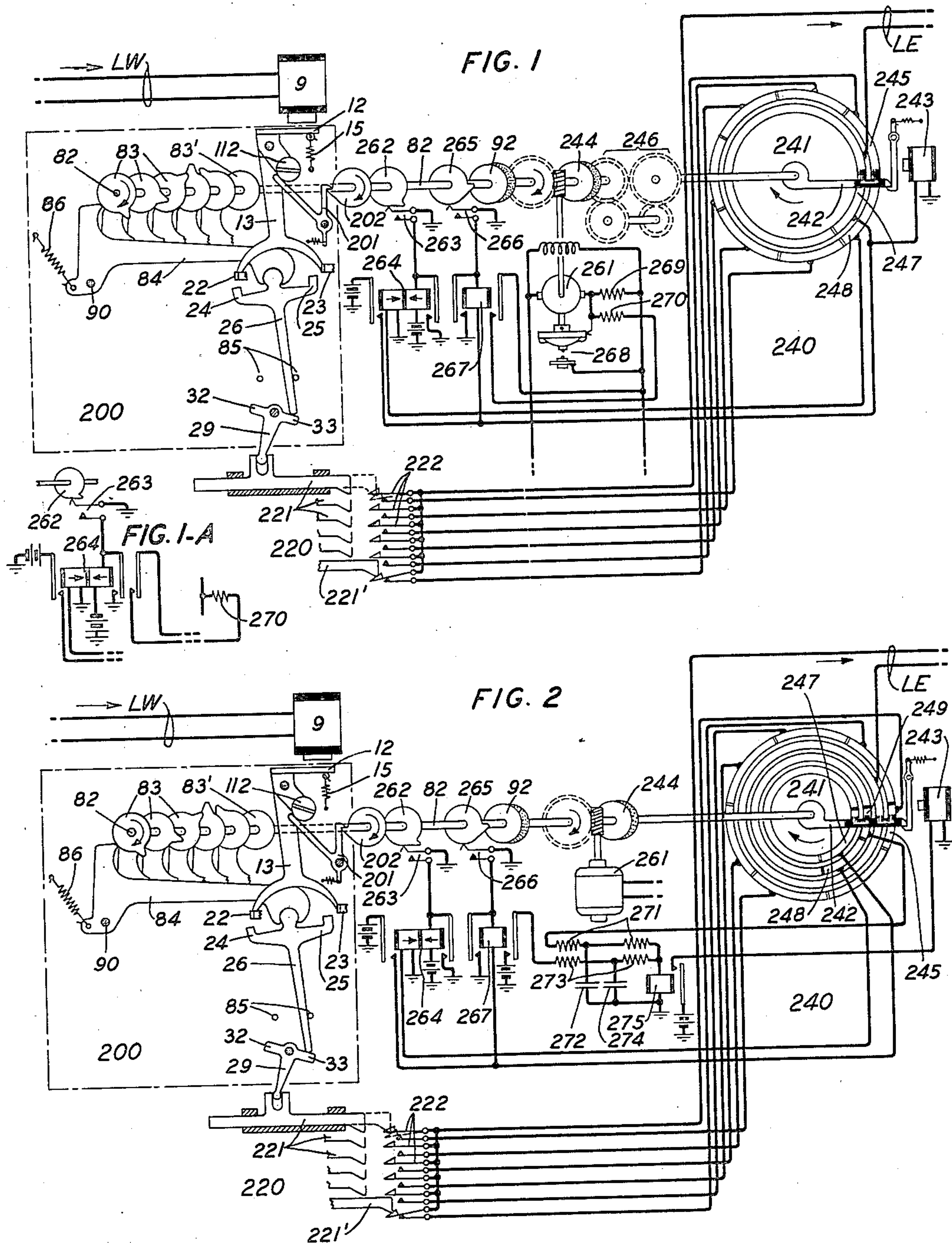
Jan. 28, 1936.

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2,028,835

START-STOP TELEGRAPH REPEATER

Filed Oct. 23, 1934



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2,028,835

START-STOP TELEGRAPH REPEATER

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Application October 23, 1934, Serial No. 749,634

22 Claims. (Cl. 178—70)

This invention relates to start-stop telegraph repeaters and more particularly to repeaters of this type which are usually called regenerative repeaters or regenerators since they are designed to receive distorted signals from one line section and retransmit corresponding regenerated signals into another line section.

An object of the invention is to reduce in repeaters of this type certain distortion effects upon the regenerated signals caused by varying operating conditions such as varying distortion suffered by the received signals or variations in speed suffered by the driving means for the repeating apparatus, with the further objects of more efficiently utilizing line-time and thus of increasing the efficiency of the telegraph plant, and with the further objects of permitting the use of successive stages of repeaters without danger that the distortion effects accumulate and cause impulses to be lost and thus of permitting extension of the line circuits almost without limit.

A further object is to provide a type of start-stop regenerator which is suitable for series inclusion in long lines.

A still further object is to provide a start-stop repeater which will operate satisfactorily with signal codes having a one-unit stop impulse, no matter whether the stop impulse be in addition to the character impulses of a signal or it be coincident with the last character impulse of the series.

As the term implies, start-stop signals are usually each composed of a start impulse and a stop impulse, besides the intermediate character impulses; the start impulse and the stop impulse are of opposite characteristics and serve to keep the remote repeating and receiving station equipments in synchronism with the transmitting station equipment.

Due to the ever present demand for increased speed and efficiency various codes have been proposed for decreasing the signal time. The code most generally used at present is a $7\frac{1}{2}$ unit code, having a start impulse and five character impulses of one-unit length each and a stop impulse of one and one-half unit length; for special purposes an $8\frac{1}{2}$ unit code with six character impulses is used. It has been proposed to save line-time over these standard codes by reducing the stop signal to one unit, and also by letting the last character signal serve as the stop signal.

Since the unit impulse, corresponding to the so-called dot-frequency, is of the shortest duration that will permit its transmittal under prevailing standard circuit conditions with no more

distortion than will insure its proper reception, it is evident that this unit must be maintained as the minimum for all impulses in any code proposed for decreasing the signal time. This criterion has been found difficult of application to codes where the stop impulse is shortened to be normally one unit in length, especially with repeater equipment which is at all practical for use in the modern efficient plant.

The principal difficulty is found in the dependence of the timing of the transmitting or sending equipment upon the incoming or receiving equipment of the repeater, and the more closely these equipments are timed or coupled the less are the chances of securing satisfactory operation in this respect, as will now be explained.

In a simple form of regenerative start-stop repeating device the receiving and sending distributors are driven through a common friction clutch and thus are started simultaneously and stopped simultaneously. For normal reception the device is started near the beginning of the incoming start impulse. The receiving side is arranged to be responsive during only a small fraction of the time of each incoming character impulse and with normal reception each response period is coincident with the center of each character impulse, whereby the possibility of producing false signals is reduced to a minimum, as is well known. The stop impulse period will normally be of full duration, namely, one and one-half units in case of the $7\frac{1}{2}$ and $8\frac{1}{2}$ unit code, this time being composed of a little more than half a unit traveling time and a little less than one unit stopping time; in the case of the codes with a one-unit stop impulse the normal stopping time of the repeating device will be a little less than half a unit.

The sending side is arranged so that the transmission of each impulse commences shortly after the center of the corresponding received impulse has been passed, the lapse or storing time usually being a fraction of a unit and serving to provide time for the device to fully respond to each incoming impulse before transmitting the corresponding outgoing impulse; the total fixed lag between the two devices thus is a little greater than one-half unit. The duration of each outgoing impulse is one unit; except that the stop impulse will be nearly of one and a half unit or of one unit duration, respectively, for the two types of codes, of which about half a unit occurs during the next incoming start impulse.

The assumption so far has been that normal or tape transmitted signals have been received over

a normal line. Different irregular conditions may arise which will affect the normal scheme of operations differently, of which the following are the most important:

1. Keyboard transmission with its varying length of stop impulses;
2. Distortion of incoming signals due to line conditions;
3. Variation in speed of the driving shaft of the sending mechanism.

Considering the first condition it is well understood that the only attendant irregularity is in the varying prolongation of the incoming stop impulse. This will result in a longer stopping time for the repeater and in transmission of correspondingly longer stop impulses, with no ill effect on the signals, but with a loss in line-time which is inherent to this type of operation.

Considering then the second condition the effect of changing line conditions is in general well taken care of by the shortening and orienting of the response periods of the receiving equipment already referred to; however, since the receiving equipment is started as soon as the incoming start impulse is strong enough to operate the receiving magnet or an intermediate receiving relay it is evident that the start moment for the regenerator may be shifted considerably with respect to the center of the incoming impulses of a particular series dependent upon the distorting effect of the line circuit at any time. Line distortion will usually result in a delayed starting, whereby the previous stop time would be increased by the period of delay and the next succeeding stop time would be decreased by the same length of time if the next start impulse again be a normal one. This, of course, in turn results in the transmission of a shortened stop impulse over the outgoing line section.

When repeaters of this type are to be used serially, it is evident that the effect upon the length of the retransmitted stop impulse due to distortion of the start impulse may often be additive over successive line sections so that the stop impulse may become sufficiently shortened to cause the distant receiver to fall out of step sooner or later. This condition of irregularity is, of course, much more serious with the codes using one-unit stop impulses, and it has been one of the principal objections to the introduction of the short stop impulse codes as well as to series connection of more than two or three start-stop repeaters.

Finally considering the third type of irregularity which arises from variations in the speed of the driving shaft for the repeater in systems which do not use synchronous motors, this irregularity of course becomes noticeable only on the last few impulses of each signal series, and mostly on the stop impulse. With present day voltage and speed control of the electric power plant no bad effect need be expected on the character impulses, and when the speed is above normal the resultant prolongation of the stop impulse has no ill effect.

However, with a speed below normal, the time periods by which all the other impulses of a signal series are prolonged are deducted from the stopping time and the effect upon the retransmitted stop impulse will be similar to that due to distorted start impulses. It is evident that irregularity due to reduced speed may seriously aggravate that due to distorted start impulses when these conditions are coexistent.

The discussion has been limited to the case

where the incoming and outgoing elements of the regenerator are driven by a common friction clutch and thus have a fixed lag between them.

It has been proposed to have the two sides of the repeater equipment operated independently, i. e. start independently and stop independently, and timed together in some manner to have the same average impulse frequency.

Thus, it has been proposed to have the receiving and sending equipments operated by separate driving means and to store the received impulses, for example, by perforations in a tape and to control the transmitting contacts by the perforations for production of the outgoing impulses. Such a mechanism would have certain disadvantages for the general use contemplated, one being that the delay in passing a break signal would be excessive.

It has also been proposed to drive the receiving and sending equipments by a common shaft but through separate friction drives, and to provide for storage of one or a few impulses of a signal series representing a character, thereby permitting the sending equipment to continue its cycle of operation for some time after the receiving equipment has come to its stop position. The lag has been fixed at a desired angle allowing for the storing of impulses, and the transmission of a character is commenced before its reception is completed. Such a mechanism may be built at reasonable cost, is simple in operation and will not unduly delay a break signal. Mechanisms of this general type have been operating for a number of years.

Whereas these latter types of regenerators, as compared with the regenerator driven through a single friction clutch, provide greater freedom in the choice of lag and in the choice of storing means and also permit the sending equipment to complete the transmission of the stop impulse even though the receiving equipment has reached its stop position, yet they have about the same serious disadvantages when used under the adverse conditions at which the improvements secured by the invention are aimed. Thus since the lag is fixed the starting of the sending mechanism will be directly dependent upon the distortion of the incoming start impulse and the stopping time of the sending mechanism will in turn be directly dependent upon that same distortion. The effect of reduction in the motor speed below normal will also result in a shortening of the retransmitted stop impulse. In these respects there is little, if any, advantage in the two-clutch regenerator over the one-clutch regenerator.

Thus it is a further object of the invention to provide a repeater of the type referred to which has a variable lag between its receiving and its sending equipments.

A particular object of the invention is to provide a variable lag in a repeater of this type and to maintain this lag within predetermined limits in such a manner that the undesirable effects of abnormal conditions are distributed over a plurality of successive signals so that the effects on the single signal series become insignificant and harmless.

In accordance with the invention undue shortening of the stop impulses, due to causes such as referred to above, is prevented under such irregular operating conditions as may reasonably be expected in a commercial plant by the provision of a signal repeating or regenerating device having its receiving and sending equipments

driven separately, or more specifically, driven through separate friction clutches by a common motor, and in which means are provided for storing impulses received by one equipment for variably delayed transmission by the other equipment.

In accordance with the invention, the receiving mechanism of the repeating device is operated through a friction clutch as nearly as practically possible at synchronous speed, i. e. in synchronism with the incoming impulses, and is stopped shortly after half a unit of the stop impulse has been received. The sending equipment is operated through a separate friction clutch and its starting may be controlled in some respects by orientable means associated with the receiving equipment. Means for storing of impulse characteristics are provided between the two equipments to permit a lag between them. At normal operation, as with tape transmitted signals, the retransmitted impulses will be sent in synchronism with the incoming impulses although delayed by the lag, the period of sending a signal series never being appreciably less than that of sending the series by the distant transmitter so that the stop signals always will be repeated with full length.

Broadly stated, the arrangement for maintaining synchronism in accordance with the invention is as follows:

The sending side is given a limited freedom of operation relative to the operating cycle of the receiving side, i. e. the lag of the sending cycle behind the receiving cycle is variable within predetermined limits. Orientable means are included in the receiving mechanism for preventing the sending side from starting too soon, the effect of this arrangement being at certain times to prolong the retransmitted stop impulse without any danger of loss of synchronism or distortion of outgoing impulses. Timed means are provided which become effective after a certain limiting lag has been reached due to abnormal delay or slowing up of the sending side, the effect of the timed means being to speed up the sending mechanism with respect to the incoming signals. The timed control means has only a limited shortening effect upon the individual sending cycles or individual stop impulses but the speeding up effect increases with the length of the lag impressed by the abnormal conditions so that there is no danger of the lag exceeding the predetermined maximum; the speeding up effect is small during any particular signal series but is accumulative over a number of series until a balance between a continuing disturbing influence and the speeding up effect is established, or else until the normal lag relation has been reestablished upon the disappearance of the disturbing effect.

These features of the invention are applicable in principle to any type of regenerator equipment with separate drives for the receiving and sending mechanisms, whether provided for storing of several signal series or of one or more impulses of only one signal series.

In accordance with one embodiment of the invention the receiving mechanism of a start-stop regenerator is operated at a speed whereby it will have a desired stopping period, but the sending mechanism is operated at a slower speed so that with the fast tape transmitted signals it will normally have no stopping period. Assuming that a distorted start impulse arrives, delaying the starting of the receiving mechanism, the

sending mechanism would be stopped during the delay and thus would be delayed beyond the fixed lag in sending the accompanying signal series; when the next or some subsequent start impulse again arrives on time the sending mechanism will be abnormally lagging behind. Also, whenever the sending mechanism is running at lower speed than normal, it would be falling more and more behind the receiving mechanism. Control means are therefore provided in this embodiment for preventing the sending mechanism from lagging too much behind. The effect of this means is to gradually speed up the driving means for the sending mechanism either until a new balanced condition is established, under which synchronism is maintained at a certain lag dependent upon the prevailing disturbing circumstances, or until the lag is reduced to normal upon the cessation of the disturbance. The speed control means are automatically responsive to the varying lag of successive signals and are effective only during the lag between the start times of the two equipments. Due to the sluggishness of the driving means the speeding-up effect becomes stronger as the lag is extended, thereby providing a stable system. The total reduction in lag requires the passing of several successive signal series, so that the shortening of the signal period becomes insignificant for the individual impulses and thus will cause no distortion or loss of synchronism.

In accordance with another embodiment of the invention the receiving and sending mechanisms are operated at the same speed and the sending mechanism normally comes to a stop at the end of each signal series. The stopping time is controlled by timed means which during normal operation have a constant time factor which fixes the minimum lag. The sending mechanism will become delayed by the arrival of a distorted start impulse or by reduction in the speed of the driving shaft. Control means are provided in this embodiment whereby the sending mechanism is prevented from lagging behind the receiving mechanism more than a predetermined maximum angle, by slightly shortening each stop period of the sending mechanism and thus gradually reducing the lag.

The effect of this control means is to vary the time factor of the timed means which control the stopping time of the sending mechanism so that after an abnormal delay either a stopping time is established at which a balanced condition is maintained dependent upon the continuing disturbing influences, or else the normal stopping time is restored after the disturbance ceases. The control means are effective only during the lag between the start times of the two equipments, and in accordance with its time characteristic its effect on the stopping time grows stronger as the lag is extended, thereby providing a stable system. Also in this embodiment the total reduction of the lag requires the passing of several successive signal series, so that the shortening of each stopping time and each stop impulse becomes insignificant and distortion and loss of synchronism is prevented.

The invention will now be described more in detail as applied to the two different embodiments already referred to. Reference will be made to the accompanying drawing in which

Figure 1 is a diagrammatic showing of a start-stop signal regenerator in which the speed of the sending equipment is varied to compensate for disturbance effects;

Fig. 1a shows a modification of a portion of the system shown in Fig. 1, and

Fig. 2 is a diagrammatic showing of a start-stop signal regenerator in which the stopping time of the sending equipment is varied to compensate for disturbance effects.

Both of these embodiments have been shown with similar receiving, storing and sending equipments for the sake of simplicity, however, it is evident that various other types of equipments may be controlled in accordance with the features of the invention.

Thus both Figs. 1 and 2 show a receiving mechanism 200 which has parts and functions similar to parts and functions of the receiving mechanism disclosed in Figs. 20 to 23 and Fig. 23 in Patent No. 1,904,164 issued to Morton et al. on April 18, 1933. This mechanism has a receiving magnet 9 connected to respond to signal impulses in coming over the west line circuit LW. Instead of setting selecting bars for a printing mechanism as in the patent, this receiving mechanism is used to set slide bars of a storing mechanism 220 for storing of impulse characteristics representing incoming signal series.

The storing mechanism in turn is connected to the sending mechanism 240 which is a well known rotating start-stop distributor with segments and wiping brushes. This distributor is connected to retransmit signals over the east line circuit LE.

The regenerators shown in Figs. 1 and 2 are arranged for operation on a five-unit signal code with separate start and stop impulses; the stop impulse is normally of one unit length.

The receiving equipment is controlled by the receiving magnet 9 which operates the armature 12 against the tension of spring 15. To the armature is fixedly attached a lug with a cam 112 for operating a set of start levers 201 cooperating with the start cam 202; also attached to armature 12 is a bifurcated lever 13 having laterally extending arms 22 and 23 for control of the setting of the storing mechanism in accordance with the operation of magnet 9 by incoming impulses.

A plurality of selector fingers 26, in this case six fingers, are individually pivoted, for rocking and for longitudinal movement, in sockets on six bell cranks 84, which in turn are pivoted at 90 and have arms individually engaging six cam surfaces 83 under the tension of springs 86.

The selector fingers 26 have arms 24 and 25 for selective engagement with the arms 22 and 23 respectively, depending upon the position of armature 12, the engagement being accomplished by the rocking movement of bell cranks 84 and resulting in the fingers 26 plying between two stops 85 and in their two positions engaging individually arm 32 or 33 of six T-levers 29 for longitudinal shifting of six slide bars 221 in the storing mechanism 220.

The camming surfaces 83 are shown as individual cam members fastened to the shaft or cam barrel 82 driven through a friction clutch 92 and necessary gearing by a motor 261. Each cam member 83 has a projection for rocking of its associated bell crank 84, and these projections are displaced relatively about the cam barrel, so that the bell cranks are rocked successively and in time with the rest periods of the armature 12.

There is a set of these operating units in the receiving mechanism and in the storing mechanism for each of the five character impulses and for the stop impulse, but none for the start impulse.

The speed of the cam barrel is such that it will

complete one revolution and will normally stop for about half a unit during the time of a normal signal series; and the angular relation of the projections on the cam members 83 to the start cam 202 is such that, upon reception of a normal start impulse, the bell cranks 84 will be given a short recocking movement successively and in synchronism with the arrival of the center of the successive character and stop impulses.

The storing mechanism 220 comprises the six slide bars 221 and six contact pairs 222 which are individually opened or closed in accordance with the setting of the bars by the receiving mechanism.

The transmitting equipment has the usual segmented rings on a distributor face 241, a rotating brush arm 242 and a start magnet 243 with start latch for control of the starting and stopping of the brush arm. The brush arm is driven through a friction clutch 244 by the motor 261; a separate motor may however be provided.

In general the operation of the systems shown in Figs. 1 and 2 is as follows: The magnet 9 responds to an incoming signal series of seven impulses by rocking the armature 12. The armature is normally held attracted by the line current during the stop impulse and is released when the line is opened for the start impulse. This first rocking releases the start cam 202 and the cam barrel or shaft 82 which is constantly subjected to a driving force through the friction clutch 92.

As the cams 83 thereupon rotate successive bell cranks 84 will be rocked to bring the arms 24 or 25 of successive selecting fingers 26 in engagement with the transverse arms or bars 22 or 23 respectively, depending upon the position of armature 12 at the moment of each engagement; the fingers 26 will thus be swung to the right or the left and in returning to their lower position with the returning bell cranks will engage the arms 33 or 32 respectively, thereby causing the T-levers 29 to set their associated slide bars 221 to the left or the right.

Upon completion of a revolution the cam barrel 82 is again stopped and held against rotation by the stop lever 201 until the next start impulse arrives. Normally the cam barrel is stopped immediately after the cam 83', corresponding to the stop impulse, has rocked its associated bell crank to set the slide bar 221', and the stopping time will last for the remainder of the stop impulse unit.

It will be noted that the slide bar 221' corresponding to the stop impulse is shown in the drawing as normally holding its associated storing contact closed. During the transmission of ordinary message characters the bar 221' will always remain in this position, so that the line LE will be closed whenever the transmitting distributor brush 242 passes over or rests on its stop segment 245. For special purposes, as for a break signal, when the line LW will be held open continuously for the length of time of two or more signal series, the bar 221' will be set to the left, thereby permitting a similar continuous signal to be transmitted over the line LE.

The five contacts 222 corresponding to the five character impulses of a signal series, and being set in accordance with those impulses, will act to open or close the line LE as it is extended to them through the corresponding segments on distributor 240 by the passing of brush 242 during one rotation. The line LE always being open for the start impulse, it is not connected to a start segment on the distributor.

The control of the lag between the receiving equipment 200 and the sending equipment 240 being different for the two systems shown in the drawing, it will be described separately for each.

Thus referring particularly to Fig. 1, the distributor brush 241 is rotated through a gearing 246 so that it will make just one revolution in the total time of a normal signal series; the brush thus will normally have no stopping time and all the segments will be of equal length.

For the purpose of maintaining a minimum lag between the mechanical receiving distributor and the sending distributor a start cam 262 on the cam barrel 82 is arranged to momentarily close contacts 263 and operate relay 264 shortly after the cam shaft 82 has been started. Relay 264 locks itself up and energizes the sending start magnet 243 to withdraw its stop latch from brush 242. Under normal operation this will happen just in time to permit the brush 242 to pass without stopping. If the motor speed should be too high, or in case the starting of the cam barrel 82 should be delayed by a distorted start signal there will be a corresponding stop of the brush arm 242. As soon as the brush arm reaches the auxiliary segments 247 and 248 the left hand winding of relay 264 will be energized and, being opposed to the right hand winding, it causes the relay to release and be in readiness for the next start operation.

In case the receiving distributor should gain on the sending distributor, as by an advance in starting time of the receiving distributor or a slowing down in speed of the motor 261, a maximum is fixed for the lag by increasing the speed of the motor as soon as the lag exceeds a certain time period.

The speed of motor 261 is controlled by a governor 268, which in a well known manner intermittently short-circuits a resistance 269 in the supply circuit for the motor; the motor speed thus varies continuously between two narrow limits, and the average speed may be kept within predetermined limits in spite of such variations in the supply voltage as may ordinarily be expected.

For the purpose of increasing this average speed a resistance 270 is automatically bridged across the resistance 269, when it becomes necessary to limit the lag between the two distributors. A lag controlling cam 265 on cam barrel 82 is arranged to momentarily close contacts 266 which prepare an operating circuit for a relay 267 which extends to battery at the left hand contact of relay 264. With relay 264 operated at this time relay 267 will operate and lock itself, and will cut resistance 270 in to increase the motor speed. Relay 264 and thereupon relay 267 release as soon as the brush arm 242 reaches the segments 247 and 248. Thus the resistance 270 is cut in for a length of time which increases as the lag increases, so that the motor speed will be more increased the greater the lag. Due to the high inertia of the motor and the other revolving parts the speed builds up very slightly during a single cycle of operations so that the effect on the individual impulse units is imperceptible. A stable condition may not be reached until after several revolutions of the regenerator.

With provision for storing a complete signal series on the storing mechanism 220 the maximum lag may of course approach a full revolution. The maximum lag may be predetermined by positioning of the lag control cam 265 relative to the start control cam 262, or by the value of

resistance 270, and it would ordinarily be limited to be less than half a revolution.

In a special case cam 265 might be adjusted so that relays 264 and 267 would operate simultaneously.

The speed control obtained by this special case could also be obtained by controlling the circuit for resistance 270 directly by relay 264, in which case relay 267 and cam 265 with contacts 266 may be dispensed with. This modification is indicated in the diagram shown in Fig. 1a, in which the parts are numbered to correspond to corresponding parts in Fig. 1.

The arrangement shown in Fig. 2 is much like that described above. However, instead of allowing the sending brush 242 to rotate freely for a number of signal combinations and controlling the lag by increasing the speed of the motor 261, the sending brush arm is stopped for a short interval during each revolution and this stop time is shortened gradually whenever the brush arm lags too far behind the operation of the receiving cams 83. The detailed operation of the arrangement is as follows:

At the beginning of rotation of the cam shaft 82, contacts 263 are closed under action of cam 262 and relay 264 is operated and locks itself. The latter closes a circuit from battery over segments 247 and 249 on the distributor 241, the brush being in stop position, through a resistance-capacity combination 271, 272 to the grounded winding of relay 275. The network 271, 272 is a slow-acting circuit arrangement having a predetermined time constant such that the application of the battery by relay 264 causes the operation of the relay 275 to be delayed for a time interval corresponding at least to the theoretically allowable stop time of the brush arm 242. The operation of relay 275 in turn connects battery to the start magnet 243 causing the operation of the start latch and permitting the brush arm 242 to make one revolution. The sequence of operation will then be repeated.

The effects of incorrect motor speed, lag, etc., are practically the same in this arrangement as in the arrangement of Fig. 1. For the case where the motor speed is too slow, the operation of relay 267, during the interval between the closing of contact 266 and the releasing of relay 264 by the sending brush passing over segments 247 and 248, will connect battery to the resistance-capacity combination 273, 274. The latter network has a much larger time constant than the combination 271, 272 so that the effect will be to pass a small current in an operating direction through the winding of relay 275. This will tend to aid the current through the relay from the network 271, 272 and thereby reduce the time required to operate relay 275 and consequently the stop time of the brush arm 242. The earlier relay 267 is operated the greater will be the value to which this additional operating current will rise and the sooner relay 275 will be operated. As a result, the sending brush arm will be advanced gradually during successive revolutions until it is able to release relay 264 before contact 266 is closed. It is therefore obvious that the period of rotation of the sending distributor also in this arrangement is automatically controlled with respect to the period of rotation of the receiving distributor in accordance with the disturbing influence.

What is claimed is:

1. The method of repeating telegraph signals which comprises retransmitting successive sig-

nal impulse series with a lag between incoming and outgoing signal impulse series which varies in response to varying operating conditions, changing once during each impulse series the speed of retransmission to be higher at any large lag than at a smaller lag to automatically limit the lag not to exceed the time of retransmitting one signal impulse series.

2. The method, in accordance with claim 1, in which the speed of retransmission is changed once during each impulse series for a duration varying in accordance with the varying operating conditions.

3. The method, in accordance with claim 1, in which the speed of retransmission of any one impulse series is changed a small amount without perceptible distortion of any outgoing impulse and the speed of retransmission is changed during a sufficient number of successive impulse series to obtain the total limitation for the lag corresponding to any particular operating condition.

4. The method, in accordance with claim 1, in which the speed of retransmission is varied by slightly varying the duration of at least one of the impulses in each of a plurality of successive outgoing signal series.

5. The method of repeating start-stop telegraph signals which comprises retransmitting signal impulse series with a lag between incoming and outgoing impulse series which varies in response to varying operating conditions, changing the speed of retransmission to be higher at a large lag than at a small lag to automatically limit the lag not to exceed the time of retransmitting one impulse series, said change in speed taking place during retransmission of both the character impulses and the synchronizing impulses of each impulse series.

6. The method of repeating start-stop telegraph signals which comprises retransmitting signal impulse series with a lag between incoming and outgoing impulse series which varies in response to varying operating conditions, changing the speed of retransmission to be higher at a large lag than at a small lag to automatically limit the lag not to exceed the time of retransmitting one impulse series, the speed of retransmission being varied by varying the duration of the stop impulse of each of a plurality of successive outgoing signal series.

7. The method of synchronizing a start-stop telegraph repeater which comprises operating the repeater with a lag between the receiving and sending mechanism which is varied in response to varying operating conditions, gradually lengthening or shortening the operating cycle of the sending mechanism in response to a lengthening or shortening, respectively, of the lag to limit the lag to be less than an operating cycle, the change in duration of the operating cycle being substantially uniformly distributed over several successive signal series.

8. The method, in accordance with claim 7, in which the change in duration of the operating cycle is obtained by changing the speed of rotation of the sending mechanism.

9. The method, in accordance with claim 7, in which the change in duration of the operating cycle is obtained by varying the stopping time of the sending mechanism.

10. The method, in accordance with claim 7, in which the change in duration of the operating cycle is obtained by changing the speed characteristics of the driving motor for the sending

mechanism during a part only of the operating cycle, the ratio of the part to the total of the operating cycle being determined by the lag.

11. The method, in accordance with claim 7, in which the lag is timed to have a determined duration and the change in duration of the operating cycle is obtained by changing the timing characteristic of the timing means for the lag during a fraction only of the operating cycle, the fraction being determined by the lag.

12. The method of repeating start-stop telegraph signals which comprises the retransmission of signal impulse series with a lag between incoming and outgoing series varying in response to varying operating conditions, and limiting the lag to prevent loss of any impulse by shortening the overall transmitting time of several successive outgoing signal series without perceptible distortion of any one impulse of the successive series.

13. The method of synchronizing a start-stop telegraph repeater which comprises operating the receiving mechanism to have a stopping time for each operating cycle, operating the sending mechanism to have a different stopping time for each operating cycle, and slightly reducing the stopping time of the sending mechanism for a plurality of successive operating cycles to decrease the phase difference between the incoming signals and the outgoing signals.

14. The method of synchronizing a start-stop telegraph repeater which comprises operating the receiving mechanism to have a stopping time for each operating cycle, operating the sending mechanism to have no stopping time during normal reception by the repeater, and slightly increasing the speed of the sending mechanism for a plurality of successive operating cycles to decrease the phase difference between the incoming signals and the outgoing signals.

15. The method of repeating start-stop telegraph signals which comprises operating the receiving mechanism of a repeating device in synchronism with incoming signals, operating the sending mechanism of the repeating device with a lag behind the receiving mechanism variable in response to varying operating conditions, impressing an incoming signal impulse series upon the receiving mechanism, successively storing the single impulses of the series, and then impressing the impulse series upon the sending mechanism for transmission with substantially the same total sending time as that of the incoming impulse series at any lag between the receiving and sending mechanisms, repeating the said operations for a plurality of successive signal series, and imperceptibly reducing the sending time of each of several successive outgoing signal series, so that the accumulative reduction is sufficient to reduce the lag due to abnormal operating conditions to be within the limit determined by the storing capacity of the repeater.

16. A start-stop telegraph repeater comprising signal receiving means including first distributing means having periodically functioning stopping means individual thereto, signal transmitting means including second distributing means having periodically functioning stopping means individual thereto, timing means controlled by said first distributing means for securing a minimum lag between the operating cycles of said first and second distributing means, variable circuit means controlled by the lag between said first and second distributing means for varying the duration of the operating cycle of

said second distributing means to limit said lag within a predetermined maximum.

17. A repeater, in accordance with claim 16, in which the timing means includes mechanically operated contact means displaced a fixed angle from the stop position of said first distributing means and in which said circuit means includes mechanically operated contact means displaced a fixed angle from the stop position of said second distributing means.

18. A repeater, in accordance with claim 16, which further comprises relay means for controlling said variable circuit means, contact means for operation and self-locking of said relay means at a substantially fixed time after starting of said first distributing means, and other contact means for unlocking of said relay means at a substantially fixed angle after the starting position of said second distributing means.

19. A repeater, in accordance with claim 16 in which said first distributing means has contact means for initiating and said second distributing means has contact means for discontinuing the control by said lag of said variable circuit means to make said circuit means effective in varying the duration of the operating cycle of said second distributing means only during a comparatively short period of each of several successive operating cycles to produce a total lag compensation without perceptibly distorting any individual outgoing impulse.

20. A start-stop telegraph repeater which comprises signal receiving means including first distributing means having a stop position and first lag control contact means disposed at a fixed

angle after said stop position, signal transmitting means including second distributing means having a stop position and second lag control contact means at a fixed angle after said stop position, variable control means having a normal and an alternate characteristic for varying the duration of the operating cycle of said second distributing means, relay means responsive to said first contact means to control the starting of said second distributing means and to vary said control means to have its alternate characteristic and responsive to said second contact means to vary said circuit means to have its normal characteristic.

21. A telegraph repeater, in accordance with claim 20, further comprising a driving shaft for said second distributing means operating at a speed such that the second distributor normally has no stopping time, and said variable control means including a driving motor for said shaft having a normal speed and being connected to said relay means for varying of its speed to thereby vary the duration of the operating cycle of said second distributing means.

22. A telegraph repeater, in accordance with claim 20, in which said second distributor means has a short stopping time and in which said variable control means comprises a network having a branch for determining the normal stopping time of said second distributor and having another branch for changing the said stopping time under the control of said relay means to thereby vary the duration of the operating cycle of said second distributing means.

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