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TELEGRAPH REPEATERS

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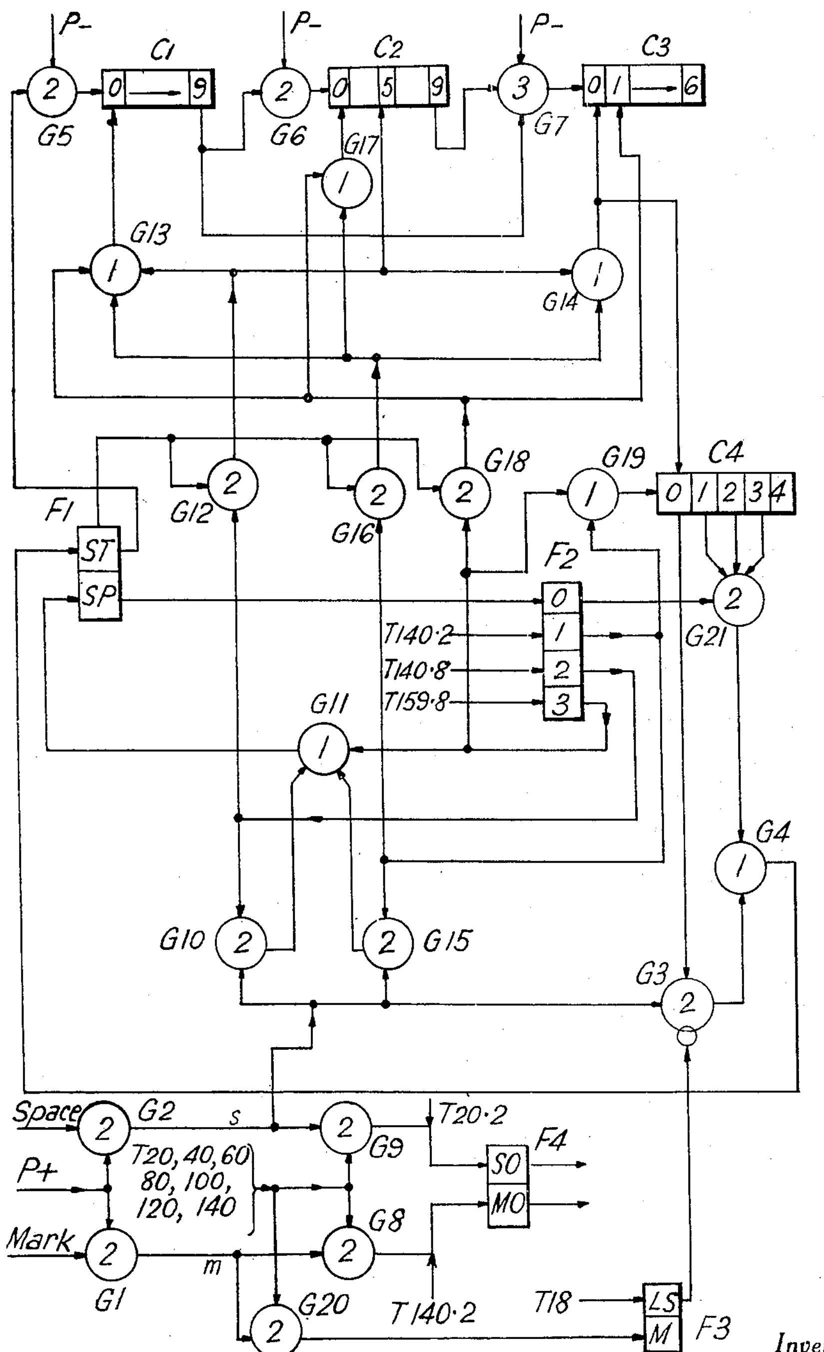

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TELEGRAPH REPEATERS

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8 Claims. (Cl. 178—70)

This invention relates to telegraph repeaters for start-stop printing telegraph signal combinations, which employ a non-continuously running time base started into operation by each successive start element.

When transmission of telegraph-signal combinations takes place over, say, a radio channel the received combinations are often found to be mutilated due to spurious interference. The interference may cause one of the code elements to be misread by the repeater. If the faulty element is one of the five permutable (i. e. intelligence-carrying) elements, then a single faulty character combination will be passed from the regenerator to the receiving teleprinter. If, on the other hand, the faulty element is the start element beginning a signal combination, then the regenerator will either start earlier or later than it should with the result that the remaining elements will be liable to be incorrectly regenerated.

The present invention provides means at such a regenerator for adjusting the time base so that even if the start transit is displaced in time the remaining elements of the signal combination are correctly examined and re-transmitted. It will be appreciated that in order to correct for an incorrectly timed start element it is necessary to know at what time the start element should have begun to arrive. When transmission is taking place under the control of a manually operated teleprinter keyboard it is not possible to determine this time. If, however, transmission takes place from an automatic transmitter under the control of, say, a perforated tape then it becomes possible to decide when a start element should arrive and whether it has in fact arrived early or will arrive late. The present invention is thus only concerned with transmission systems in which successive signal combinations are emitted by the transmitter at regular, predetermined time intervals.

In its broadest aspect the invention provides a regenerative repeater for start-stop printing telegraph signal combinations transmitted at regular intervals, comprising a non-continuously running time base for timing the regeneration operation, means for starting said time base into operation on receipt of each successive start element and means for automatically adjusting the time base to eliminate the time displacement resulting from the receipt of a mis-timed start element.

More specifically the invention provides an electronic regenerative repeater for start-stop printing telegraph signal combinations transmitted at regular intervals comprising means for examining the elements of a received signal combination, a non-continuously running time base for determining the times at which said examination takes place, means for starting said time base into operation on receipt of each successive start element and means operative when a start element arrives at any other than its expected time for automatically adjusting the time base so as to determine the correct examination times for the remaining elements of the combination following the mis-timed start element.

In the embodiment of the invention now to be described

it is assumed that start-stop seven-element signal combinations are transmitted under the control of an auto-transmitter controlled by, say, a perforated tape. Each combination (including the stop period) is assumed to take the same interval of time namely 140 milliseconds. At the end of this time the start element of the following combination should commence.

Throughout the description a telegraph speed of 50 Bauds is assumed.

An embodiment of the invention will now be described with reference to the single figure of the accompanying drawing which takes the form of a block schematic diagram of an electronic telegraph repeater according to the invention.

In order to simplify the description and drawings as much as possible, full circuit diagrams of the various gating devices, counting chains etc. have not been given but suitable references have been given to other specifications from which full particulars may be obtained. Thus, the drawing is functional in nature and is intended to show the processes involved rather than the actual means used. The various symbols will be explained as they enter the description.

In this embodiment, the invention is applied to the type of cold-cathode tube regenerative repeater which forms the subject of the co-pending application of V. J. Terry-D. S. Ridler-D. A. Weir, filed March 29, 1949, and bearing Serial Number 84,104.

Referring to the drawing, incoming signals are examined by gates G1 and G2 at times determined by examining pulses applied at point P+. These examining pulses have a repetition frequency of five kilocycles per second. Gates G1 and G2 each require two inputs before they can produce an output as denoted by the figure "2" within the gate symbol. A gate of this type is disclosed in the specification of British Patent Number 636,700 and its operation is there fully explained.

In the stop condition, marking potential is present on the line so that positive pulses are passed through gate G1 on to lead M.

When a start element is received, the opposite gate G2 conducts and pulses appear on lead S. These pulses pass to a gate G3 which also requires two inputs, the other of which may be assumed to be present at this time.

The output from gate G3 passes to a gate G4 which is arranged to provide an output for either one of two inputs. A gate of this type is disclosed in the specification of my United States Patent Number 2,653,996, granted September 29, 1953.

When the gate G4 opens, a pulse is passed to the start tube ST of a two-condition device such as a pair of trigger tubes represented by the block F1 and connected in well known manner whereby the conduction of either tube effects the extinction of its partner. Normally the stop tube SP is fired so that the pulse from gate G4 changes over the condition of F1 by firing the start tube.

The firing of the start tube of F1 causes a potential to be applied to one input of a two-input gate G5. The other input to gate G5 comes from a 5 kilocyles-per-second negative pulse source P— synchronised with the source of positive pulses P+. When gate G5 is energised from the start tube of F1, these negative pulses are passed to a time scale circuit comprising three multi-gap gas-filled discharge tubes shown as blocks C1, C2 and C3 and two further gas-filled trigger tubes shown as gating devices G6 and G7. The time scale circuit is connected and designed to operate in substantially the same manner as that shown and described in said copending application Serial Number 84,104.

The pulses to be counted are applied to the gates G5, G6 and G7 at the points P—. As explained in the last mentioned specification, C1 is arranged to count all the pulses, C2 to count every tenth pulse and C3 to count every hundredth pulse. At any particular time after counting begins, a discharge will be present across a particular gap in each tube which gap will depend upon the number of pulses counted and hence upon the time that has elapsed.

In the previously described regenerative repeater, the time scale circuit was always reset to the condition in which the first gap (0) in each tube was fired. Thus counting was arranged to take place in effect from zero, and ten milliseconds after counting started, the gaps fired were C1.0, C2.5 and C3.0. The reason for this will be apparent when it is realised that in ten milliseconds

$$\frac{10\times 5000}{1000}=50 \text{ pulses}$$

will have been counted. In the embodiment now being described it is necessary in certain circumstances to reset the time scale circuit to a position earlier than the normal. Thus it is more convenient to take the normal starting point from the ten millisecond position rather than the zero position. As will be more fully explained later the time scale circuit may be reset to the zero position, to the ten millisecond position (normal) or to the twenty millisecond position.

In said copending application Serial Number 84,104, it is further explained and shown how the simultaneous firing of two or three specific gaps in respective tubes may be used to open a gating circuit at a particular time. In order to reduce the complexity of the drawing in the present case, circuits for connecting the outputs of the counting tubes with various gates which are required to be opened at specific times have been omitted, but, instead, the times at which potentials are derived from the time scale circuit are shown against various conductors connected to gates thus: T20, T40, T60 etc. These are the time intervals in milliseconds represented by the condition of the gaps in the tubes C1, C2 and C3. They are, however, only representative of the time that has elapsed from the starting of the cycle if the latter started from the zero position. Since the time scale circuit is normally started from a condition representing ten milliseconds, the condition representing twenty milliseconds (signified by time T20) is normally attained after only ten milliseconds. The time scale circuit is started from the 10 millisecond position by arranging that the above mentioned gaps C1.0, C2.5 and C3.0 are initially fired when counting of pulses commences.

In the regenerative repeater under consideration as in practically every other type of telegraph repeater the incoming signal elements are examined at their respective centres. Thus the examination times for a normal repeater are 10 milliseconds for the start element, 30, 50, 70, 90 and 110 milliseconds for the five permutable elements and 130 milliseconds for the stop period. Since in the present embodiment the time scale circuit is normally started from the ten milliseconds position, the corresponding examination times are 20, 40, 60, 80, 100, 120 and 140 milliseconds respectively.

The examination of the incoming signal elements is performed by gates G8 and G9 connected respectively in the mark lead M and the space lead S.

At 20 milliseconds (i. e. 10 milliseconds after the starting of the time scale), the start element (which will be assumed to have arrived unmutilated) is examined at its centre and gate G9 passes a pulse forward to the space tube SO of the output two-condition device F4. In the stop condition the mark tube MO of device F4 is fired so that marking potential is applied to the outgoing telegraph line. When the pulse is passed to the space tube SO, this tube is fired, MO is extinguished and spacing potential is applied to the outgoing line to signify the beginning of a start element.

At 40, 60, 80, 100 and 120 milliseconds (i. e. 30, 50,

70, 90 and 110 milliseconds respectively from the starting of the time scale circuit) the five permutable elements of the signal combination are examined by gates G8 and G9 and the output two-condition device F4 is conditioned to pass the appropriate marking or spacing potentials to the outgoing line.

At 140 milliseconds (i. e. 130 milliseconds from the starting of the time scale circuit) the stop signal is examined on the line M by gate G8 and the mark tube MO of the device F4 is fired (if not already fired) to pass the stop signal to the outgoing line.

At 140.2 milliseconds a pulse is applied to tube 1 of a four-condition device F2. This device comprises, for example, four trigger tubes interconnected in such manner that the firing of any one tube extinguishes any previously fired tube. The tubes could, for example, share a common anode load resistance so that when any one tube is fired the fall in potential on its own anode is communicated to the anode of the previously fired tube. The anode-cathode gap voltage of the latter falls below the maintaining level and the discharge is quenched. Initially tube 0 of device F2 is fired and the potential applied at140.2 milliseconds causes tube 1 to be fired and tube 0 to be extinguished.

The firing of tube 1 of F2 causes a pulse to pass through a gate G19 to step the discharge in a counting tube C4 from gap 0 to gap 1. The purpose of this counting tube will be explained later.

At 140.8 milliseconds, tube 2 of F2 is fired and supplies one input to a gate G10 whose other input is supplied when the space lead S is energised.

At 150 milliseconds (i. e. 140 milliseconds after the starting of the time scale circuit) the start element of the succeeding combination should arrive. Assuming this arrives correctly, the first pulse on lead S is passed through gate G10 and a gate G11 to fire the stop tube SP of the two condition device F1.

As F1 changes over, a transient voltage pulse (produced, for example, by induction) is passed to a gate G12 whose other input is supplied from tube 2 of F2 which was fired at 140.8 milliseconds. G12 passes a resetting pulse directly to gap 5 of counting tube C2 and (via gates G13 and G14 respectively) to gap 0 of tubes C1 and C3. Thus the time scale circuit is restored to its initial condition representing a time of ten milliseconds.

As F1 changes over, the resetting pulse passed via gate G14 also restores the counting tube C4 to its initial condition with gap 0 fired. Only when this gap is fired can gate G3 have any effect.

When the stop tube SP of device F1 is fired, it resets device F2 into its initial condition with tube 0 fired.

The next pulse on the space lead S (0.2 millisecond later) causes gates G3 and G4 to open and fire the start tube ST of device F1 and the foregoing chain of events is repeated.

It will now be assumed that due to interference the next start element appears to arrive early, say at 140.6 milliseconds. The device F2 is still in the condition of tube 1 being fired. This tube supplies an input to a gate G15 whose other input is supplied when the space lead S is energized.

At 140.6 milliseconds positive pulses appear on the space lead S due to the premature start element which has been assumed to have arrived. Gate G15 conducts on the first of these pulses and fires the stop tube SP of device F1.

As F1 changes over, a transient voltage pulse is passed to a gate G16 whose other input is supplied when (as at this stage) tube 1 of device F2 is fired.

Gate G16 opens to pass a resetting pulse to reset the time scale circuit into a condition in which the first gap "0" in each tube is conducting. This resetting of tube C2 is accomplished by means of the gate G17. At the same time, counter C4 is restored to its initial condition with gap 0 fired.

When the stop tube SP of F1 is fired it resets F2 into its initial condition with tube 0 fired.

Immediately afterwards, gate G3 opens since it is receiving simultaneous inputs from gap 0 of C4 and from the space lead S still carrying the premature start element. A pulse is passed through gate G4 to fire the start tube ST of F1 thus restarting the time scale circuit. Since this occurs immediately after 140.2 milliseconds (really 130.2 milliseconds) the time scale circuit is restarted some ten milliseconds earlier than before. However, since it was reset this time to zero and not to ten milliseconds the premature arrival of a start element is compensated for and the timing of the examination periods relative to the true time of arrival of the signal elements is substantially the same as before i. e. at the centres of the signal elements.

At 20 milliseconds the condition of the space lead is examined by gate G9. If the start signal has persisted, F4 is changed over to the space condition by the firing of tube SO to signify the beginning of the retransmitted start signal.

If the start signal has not persisted then at 20.2 milliseconds F4 is positively changed over to space so that a start signal is forcibly inserted.

In an analogous manner a stop signal is forcibly inserted at 140.2 milliseconds whether or not a marking potential is present at the time.

It will now be assumed that a signal combination has been received and retransmitted correctly but that the start element beginning the succeeding signal combination arrives late or fails to arrive at all.

It has already been explained that at 140.2 milliseconds tube 1 of the device F2 is fired and causes the condition of the space lead to be examined by gate G15. If no start signal has arrived the only result is the stepping of the discharge in counting tube C4 from gap 0 to gap 1 (as a result of a pulse through gate G19).

At 140.8 milliseconds tube 2 of the device F2 is fired and the condition of the space lead is again examined, this time by gate G10 but if no start element has been received no action results.

At 159.8 milliseconds (that is 9.8 milliseconds after the start element should have begun to arrive) tube 3 of device F2 is fired and the discharge in counting tube C4 steps to gap 2.

The firing of tube 3 of F2 causes a pulse to pass through gate G11 to fire the stop tube SP of device F1.

As device F1 changes over, a pulse is passed to a gate G18 which receives a second input from tube 3 of F2.

G18 provides an output to reset the time scale circuit into a condition in which the gaps fired are C1.0, C2.0 and C3.1. This represents a time of twenty milliseconds.

It is to be noted that when the time scale circuit is reset into this condition, no resetting pulse is passed to the counting tube C4 and the discharge in the latter remains across gap 2.

When the stop tube SP of F1 is fired it resets F2 into its initial condition by the firing of tube 0. The firing of this tube supplies an input to a gate G21 which receives a second input from gap 2 of counting tube C4.

Gate G21 provides an output which passes through gate G4 to fire the start tube ST of the device F1. This, in turn, restarts the time scale circuit.

The restarting of the time scale circuit takes place at approximately 160 milliseconds i. e. ten milliseconds later than the time when it is normally restarted. However, since the starting condition of the time scale circuit has been advanced by ten milliseconds to compensate for the failure or late arrival of the start element the timing of the examination periods is substantially the same as before i. e. at the centres of the signals elements.

If the start element completely fails to arrive it is forcibly inserted at 20.2 milliseconds as has already been explained. It will be apparent that since the device assumes a start element when it has not in fact been received, means has to be provided to stop the regenerator if a number of start elements fail in succession. This is the primary purpose of the counting tube C4. It has also been explained that the discharge in this counting tube takes two steps every time a start element fails to arrive and that it is not reset in these circumstances. After two start elements have failed to arrive the discharge has passed to gap 4. In this condition no input is supplied to either of gates G3 or (via gate G21) G4. This means that the start tube ST of F1 cannot be fired and the regenerator time scale circuit cannot be restarted. It will be apparent that the counter C4 could have a greater number of gaps if desired to tolerate a greater number of consecutive characters with missing start elements.

It is sometimes desired to send a long space signal for supervisory purposes and it is essential for the regenerator to take no action except to pass a continuous spacing potential to the outgoing line.

To this end there is provided a two-condition device F3. At T18 the "long space" tube LS is fired but the first mark element thereafter acts via a gate G20 to fire the mark tube M of F3 and extinguish tube LS.

If a long space signal is received, F3 remains in the condition of tube LS being fired and this provides an "inhibiting" input (indicated by the ringed arrow) to gate G3. While this inhibiting input is present G3 cannot operate and although spacing potential is on lead S, no pulse is passed to fire tube ST of device F1 so that the time scale circuit does not restart. A gate having an inhibiting input (such as G3) is disclosed in the specification of the copending application of A. D. Odell, filed June 25, 1953, and bearing Serial Number 363,542, now Patent No. 2,688,695.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What I claim is:

1. An electronic regenerative repeater for start-stop printing telegraph signal combinations transmitted at regular intervals comprising means for examining the elements of a received signal combination, a non-continuously running time base for determining the times at which said examination takes place, means for starting said time base into operation on receipt of each successive start element and means operative when a start element arrives at any other than its expected time for automatically adjusting the time base so as to determine the correct examination times for the remaining elements of the combination following the mis-timed start element.

2. A regenerative repeater as claimed in claim 1 in which said time base comprises a continuously operating source of pulses and means normally operative on receipt of the start element of a signal combination to cause pulses from said source to be applied to a counting chain and in which the means for adjusting the time base comprises means for varying the stage of the counting chain at which counting begins.

3. A regenerative repeater as claimed in claim 2 comprising a multi-condition trigger device, means for actuating said device from its initial condition into a plurality of successive operating conditions, a plurality of examining devices each operable under control of said trigger device in a respective operating condition to examine the incoming telegraph circuit for the presence of a start element arriving at different times and means operable when a start element is detected by one of said examining devices for causing pulses from said source to be applied to an appropriate stage of said counting chain to start the next cycle.

4. A regenerative repeater as claimed in claim 1, comprising means operable if a start element has not been received at the end of a predetermined period after a pre-

vious signal combination for automatically simulating the effect of a start element by starting said time base.

5. A regenerative repeater as claimed in claim 4 comprising a counting device, means for advancing the counting device each time a start element is automatically inserted and means operable after a predetermined number of consecutive steps have been taken by said counting device to prevent the automatic insertion of any further start elements.

6. A regenerative repeater as claimed in claim 2 in which said counting chain comprises a plurality of cold-cathode electric discharge gaps connected for sequential firing by successive pulses from said source.

7. A regenerative repeater as claimed in claim 6 in which said multi-condition trigger device comprises a plurality of cold-cathode electric discharge gaps interconnected in such manner that only one gap may fire at a time.

8. A regenerative repeater for telegraph signals each consisting of the same number of elements indicated by one or other of two conditions, a source of regularly re-

peated pulses at said receiver, a time scale circuit for counting said regularly repeated pulses, means controlled by said time scale circuit for controlling the operations of said regenerative repeater, means for restoring said time scale circuit to an initial position during each cycle of duration equal to that of a telegraph signal, and means controlled by the received signals to alter the movement of said time scale circuit to compensate for apparent errors in times of arrival of the elements constituting a signal.

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