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TELEGRAPH SYSTEM

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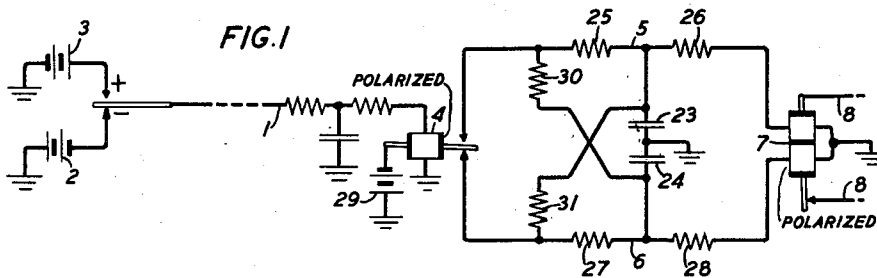


FIG. 2

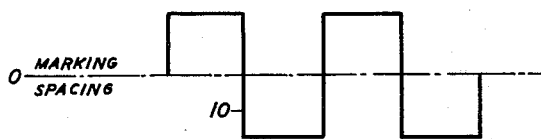


FIG. 3

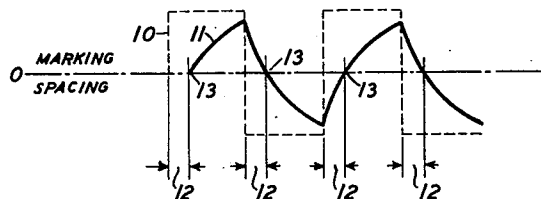


FIG. 4

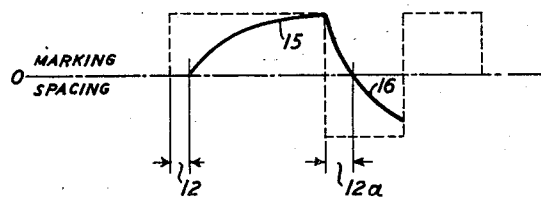
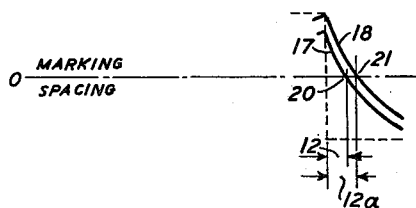


FIG. 5



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TELEGRAPH SYSTEM

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11 Claims. (Cl. 178—70)

This invention relates to telegraph systems and particularly to improvements for repeating signals in systems of this kind.

Its object is to provide a simplified arrangement for preventing moderate distortion of repeated impulses received over a single line.

Heretofore, for example, in printing telegraph systems marking signals and spacing signals may be of opposite polarity and transmitted in different combinations over a line and then repeated at repeater stations along the line. In systems of this kind distortions may be produced in repeating the signals. The usual receiving relay responsive to a marking signal may be delayed in operating to such an extent, that it will not remain operated for the proper time interval to produce a repeated marking signal of the proper length or it may fail to release in time to produce a repeated spacing signal of the required length. This is likely to occur when more than one marking or spacing signal is received in succession and may be due to the fact that the time required for the received signal current to assume its steady state value exceeds a single impulse period. If this is the case, the received current during the second signal interval may assume its full steady state value and thus when it ceases cause a correspondingly longer delay in operating or releasing the receiving relay. Thus, for example, if two marking signals were received followed by a spacing signal the marking period of operation of the receiving relay will be too long and the succeeding spacing period of release of the receiving relay will be correspondingly shorter.

It is a feature of the present invention to produce repeated signals free from such distortions introduced by the received signals. This feature may be applied in a system where the receiving relay controls a repeating relay by a marking circuit to operate the repeating relay when the receiving relay is operated and a spacing circuit for releasing the repeating relay when the receiving relay is released. In each of these circuits a condenser is connected to ground and a connection is made through a resistance from one circuit to the condenser in said other circuit and vice versa. The condensers delay the operation or release of the repeating relay until they receive a certain charge. If the receiving relay remains operated longer than the normal period the condenser in the spacing circuit will receive a charge, through the resistance in the cross-connecting circuit, which will be slightly in excess of the usual charge. Then when a succeed-

ing spacing signal is received the receiving relay will close the spacing circuit somewhat later than usual but as the condenser in the spacing circuit has already received a corresponding greater amount of charge, it will receive the required charge at the correct period and thus cause the repeating relay to release to record a spacing signal at the correct time. Similarly, if the receiving relay remains released for a longer period than usual the condenser in the marking circuit will be charged a corresponding greater amount so that when a marking impulse is later received this condenser will be more fully charged within the period and consequently the repeating relay will be operated at the proper time regardless of the delay in the closing of the marking circuit.

This invention has been illustrated in the accompanying drawing in which Fig. 1 shows a signal repeating circuit embodying the features of this invention, while Figs. 2 to 5 show diagrammatically the effects on the signal repeating circuit shown in Fig. 1 of signals received under different circumstances and how correction is accomplished.

Referring now to Fig. 1, 1 is a transmission line such as a telegraph signal line over which impulses may be transmitted from the negative signal source at 2 or from the positive signal source at 3 to receiving relay 4 which is responsive to said signals and operates in one direction in response to positive or so-called marking signals and in the opposite direction in response to negative or so-called spacing signals. These signals received by relay 4 are transmitted through a network 5 or 6 to the repeating or retransmitting relay 7 to cause it to operate in one direction or the other to reproduce corresponding signals in the outgoing circuit 8. In the outgoing circuit shown the marking signals will be represented by the opening of the circuit and the spacing signals by the closing of the circuit. This outgoing circuit is only representative of one method of repeating signals and it should be understood that other circuits may be employed without departing from the spirit of the invention.

In ordinary printing telegraph systems marking signals and spacing signals are generally transmitted in different combinations over a line such as 1, that are in accordance with some predetermined code, for example, marking signals and spacing signals may be received alternately or one or more of one type of signals may be followed by one or more of the other type of signals in various combinations. In such systems, delay in the response of the receiving relay 4 may occur

due to line attenuations and the period of delay may vary for different combinations of signals. If such systems were not arranged in accordance with the principles of this invention corresponding distortional effects on the signals would be repeated by relay 7. To illustrate how such effects may occur and be corrected, Figs. 2 to 5 have been included in the drawing and the following descriptions relating to these figures is made to aid in the understanding of the applicant's invention as described hereinafter. It should be observed that if marking and spacing signals are received alternately, delays in the operation of relays 4 and 7 would not be fatal as the delays would be the same for both kinds of signals. The delay effected by signals transmitted in this manner may be explained in connection with Figs. 2 and 3. In Fig. 2 the alternate marking and spacing signals transmitted over line 1 above or below the reference zero line are illustrated by the wave form 10. This wave form represents the full dot period of the opposite signals as transmitted in succession. In Fig. 3 the effect of these signals on relay 4 is represented by the wave form 11. If this wave form is considered as the received line current it should be particularly noted that it does not reach a steady or peak value within any dot period. This is readily observed by comparing the wave form 11 with the superimposed dotted wave form 10 of Fig. 2. The relay 4 will respond to the received signals a certain period after they were sent, but this delay in the operation of the relay is the same for both types of signals whether negative or positive. Consequently, no ill effect will be produced in the signals repeated by relay 7 as all signals are delayed the same amount. This amount of delay of the received signals is represented by the distances marked 12 in Fig. 3, as the release of the relay 4 from a marking signal and the consequent operation of relay 4 by a spacing signal will take place around the points marked 13 on the reference zero line.

This delay in the reception of signals, however, is likely to cause the repeated signals to become distorted in the case of codes comprising a succession of more than one signal of the same polarity. If, for example, as has been illustrated in Fig. 4, two marking dots are received followed by a spacing dot the peak value of the second marking dot will be higher than the normal peak value of a single marking dot. This condition is shown by the wave form at 15 in Fig. 4. Hence the succeeding spacing dot will not become effective at the normal or usual time within the dot period and will in fact not arrive at its normal peak value within the dot period as shown at 16 in Fig. 4. Consequently relay 4 will release or reverse its action in response to the spacing dot later than under normal conditions. This amount of delay is indicated at 12a. This action is further illustrated by Fig. 5 which shows two wave forms, one marked 17 representing the building up of a negative or spacing potential from a normal positive potential peak. The other wave form marked 18 represents the building up of a negative or spacing potential from a positive potential peak which is above the normal peak such as would result from the wave form 15. Consequently if relay 4 responds to current represented by form 17 it will operate around the point 20 which represents the normal delay and if it responds to the current represented by the form 18 it will operate around the point 21 which represents the delay caused by the preceding two

marking dots. It, therefore, follows that this spacing dot will in this latter case be shorter in duration than it would have been had it followed a single marking dot. Consequently, a mutilated repeated spacing signal will be produced. Similarly a mutilated marking signal may be produced if a marking signal follows two or more spacing signals.

In the present system, if relay 4 is subjected to such distortions as above described and represented by wave form 18, the repeating relay 7 will nevertheless repeat signals of the proper duration regardless of the fact that relay 4 may be operated for a longer or a shorter period than the proper period of a dot. This is accomplished by the circuits 5 and 6. If relay 4 responds to alternate marking or spacing signals the circuits 5 and 6 will be closed for the same period of time and thus cause relay 7 to repeat marking and spacing signals having the same duration. The condensers 23 and 24 would be charged to the same amount. The purpose of these condensers and the associated resistances 25, 26, 27 and 28 being to slow up the operation of relay 7, that is, relay 7 will not operate until condenser 23 or 24 has received a fixed amount of charge, depending on the electrical characteristics of these condensers, the associated resistances and the battery 29 as is well known in the art. On the other hand, if, for example, relay 4 is operated for a longer period than usual which would take place as hereinbefore described in response to the reception of the second of the two succeeding marking dots shown by the wave form in Fig. 4, the circuit 5 will be closed for a correspondingly longer period. Under these circumstances the condenser 24 will receive a charge over the path through resistance 30 that will be greater than when relay 4 is operated for the single dot period. Hence, when the succeeding spacing dot is received by the relay 4, relay 7 will as usual operate in the opposite direction as soon as condenser 24 has received its proper charge by the closure of circuit 6. But as this condenser 24 has already received an initial charge which is greater than normally received, its proper charge will be completed sooner than usual after a spacing dot is received to close circuit 6. Consequently, relay 7 will operate at the proper time regardless of the delay in closing of the circuit 6. Similarly, if two spacing dots are received in succession followed by a marking dot, the condenser 23 will receive a charge above the normal charge over the path through the resistance 31 and hence relay 7 will operate at the correct time even though relay 4 is operated later than usual to close the circuit 5.

In other words, when relay 4 remains operated to one side for a period of time which is longer than the duration of a single unit signal or impulse, then, when relay 4 is operated to the other side, relay 7 will respond faster to this reversal of relay 4 than when relay 4 remains operated on one side for only a single unit signal or impulse. Consequently the combined response time of relays 4 and 7 is substantially constant, both when they operate and when they release, so that the repeated signal impulses will not be distorted even though the receiving relay 4 receives distorted signals or distorts the received signals by having different response times under different signalling conditions.

With this means, therefore, the irregularities in the time of operation and release of the relay 4 in response to marking and spacing dots will

not become effective or interfere with the operation of relay 7 at the proper intervals.

The terms "operating time", "releasing time" and "response time" as used in the foregoing specification and also in the claims appended hereto indicate or describe the time interval between the application of a signal or current condition to the winding of the relay and the time at which the armature completes its movement in either direction due to the signal or current condition, but does not include any time the armature is held in either position by the signaling or current condition applied to the windings of the relay. The phrase "the combined response time of both relays" is used in the foregoing specification and also in the claims appended hereto to indicate the sum of the response times of the receiving relay and the repeating relay, that is, the time interval from the time the beginning of a signaling impulse is received by the receiving relay until the armature of the repeating relay is fully operated to its new position so that it starts to retransmit a corresponding signaling impulse. This time interval does not include any time during which the repeating relay is held in either of its positions by a signaling condition received by the receiving relay.

What is claimed is:

1. In an impulse repeating system, a line, two polarized relays, one relay connected to the line for the operation of said relay in response to impulses, a circuit connecting the second relay to the contacts of the first relay for causing the second relay to follow the operations of the first relay, capacitive means in said circuit for maintaining the combined response time of both relays substantially constant and independent of variations of the response time of the first relay.

2. In an impulse repeating system, a polarized receiving relay, a polarized repeating relay, means for operating or releasing the receiving relay in response to impulses of opposite polarity at a fixed interval after the reception of an impulse provided succeeding impulses are of alternate polarity and for operating or releasing said receiving relay in response to impulses at a longer interval after the reception of more than one impulse of the same polarity in succession, circuit connections including capacitive reactance for operating or releasing said repeating relay a certain interval after the operation or release of the receiving relay if the succeeding impulses are of alternate polarity and for shifting the interval of operation or release of the repeating relay after the receiving relay has responded to more than one impulse of the same polarity so that there will be substantially no shift from the normal combined operating and releasing time of the receiving and repeating relay.

3. In an impulse repeating system, a receiving relay normally responsive a certain fixed interval after the reception of an impulse of one polarity and responsive the same fixed interval after the reception of an impulse of the opposite polarity provided said impulses are received alternately by said receiving relay, a repeating relay, circuit connections including retarding impedance elements for normally actuating said repeating relay a certain fixed interval after the operation of said receiving relay and for normally releasing said repeating relay the same fixed interval after the release of said receiving relay, provided said fixed relationship of operation and release of said receiving relay is maintained and for maintaining the combined operating and releasing conditions

of both of said relays substantially constant and independent of slight changes in the operating or releasing conditions of said receiving relay.

4. In an impulse repeating system, an impulse receiving relay and an impulse repeating relay, a circuit including two resistances in series and a condenser connected between said resistances and ground for the operation of said repeating relay in response to the operation of the receiving relay, a circuit including two resistances in series and a condenser connected between said resistances and ground for the release of said repeating relay in response to the release of the receiving relay, a circuit connected between the first and second-mentioned circuits including a resistance in parallel with a resistance in the first circuit and in series with the condenser and ground in the second circuit, a circuit connection between the second and first-mentioned circuits including a resistance in parallel with a resistance in the second circuit and in series with the condenser and ground in the first circuit, the electrical characteristics of all of said circuits and circuit connections being so adjusted that operations and release characteristics of both of said relays will be maintained constant regardless of any slight distortion in the operation and release characteristics of the receiving relay.

5. In an impulse repeating system, an impulse receiving relay and an impulse repeating relay, a circuit including two resistances in series and a condenser connected between said resistances and ground for the operation of said repeating relay in response to the operation of the receiving relay, a circuit including two resistances in series and a condenser connected between said resistances and ground for the release of said repeating relay in response to the release of the receiving relay, a circuit connected between the first and second-mentioned circuits including a resistance in parallel with a resistance in the first circuit and in series with the condenser and ground in the second circuit, a circuit connection between the second and first-mentioned circuits including a resistance in parallel with a resistance in the second circuit and in series with the condenser and ground in the first circuit, the electrical characteristics of said circuits and circuit connections being so adjusted that no lag in the combined operation or release of both of said relays will be introduced by any slight, distortive lag in the operation or release of the receiving relay.

6. In a telegraph repeating system, an impulse receiving relay, an impulse repeating relay, a marking signal circuit for the operation of the repeating relay under control of the operation of the receiving relay, and spacing signal circuits for the release of the repeating relay under control of the release of the receiving relay, a circuit including a condenser connected to ground for the marking signal circuit, a circuit including a condenser connected to ground for the spacing signal circuit, a circuit including a resistance connecting the marking signal circuit with the condenser for the spacing signal circuit, a circuit including a resistance connecting the spacing signal circuit with the condenser for the marking signal circuit, said circuits operative if the receiving relay remains operated longer than a single standard period to charge the condenser for the spacing signal circuit a correspondingly longer period so when the spacing signal circuit is then closed the repeating relay will, due to the greater charge on its associated condenser, cause

a more rapid operation of the repeating relay and if the receiving relay remains released longer than a single standard period to charge the condenser for the marking signal circuit a correspondingly longer period so when the marking signal circuit is then closed the repeating relay will, due to the greater amount of charge on its associated condenser cause a more rapid release of the repeating relay.

7. An impulse repeating system comprising a receiving relay responsive to received impulses, an impulse repeating relay and an operative connection between said relays, and capacitive means included in said operative connection for automatically varying the response time of said repeating relay oppositely to the variation of the response time of said receiving relay whereby the combined response times of said two relays remain substantially constant.

8. In an impulse repeating system, an impulse receiving relay, an impulse repeating relay, circuits connecting said relays together whereby said repeating relay follows the response of the receiving relay and an impedance network connected in said connecting circuit for automatically controlling the response time of said repeating relay whereby the combined response time of said receiving and repeating relays is substantially constant.

9. In an impulse repeating system comprising a receiving relay and a repeating relay operative-

ly connected thereto, means for reducing the distortion of repeated impulses comprising impedance elements connected between said relays for varying the response time of said repeating relay oppositely to the variations of the response time of said receiving relay whereby the combined response times of both of said relays is substantially constant.

10. A telegraph impulse repeater comprising a receiving relay responsive to received telegraph signal impulses, a repeating relay connected to said receiving relay for repeating the signal impulses received thereby, retarding impedance means connected between said relays for delaying the response of said repeating relay and means for automatically reducing the delay of said repeating relay when delays in the response of said receiving relay tend to increase.

11. An impulse repeating system comprising a receiving relay having an armature and contacts, a repeating relay, a circuit fixedly connecting said repeating relay to the contacts of said receiving relay, impedance elements fixedly connected to said connecting circuit for varying the response time of said repeating relay oppositely to the variations of the response time of said receiving relay whereby the combined response time of both of said relays remains substantially constant.

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