

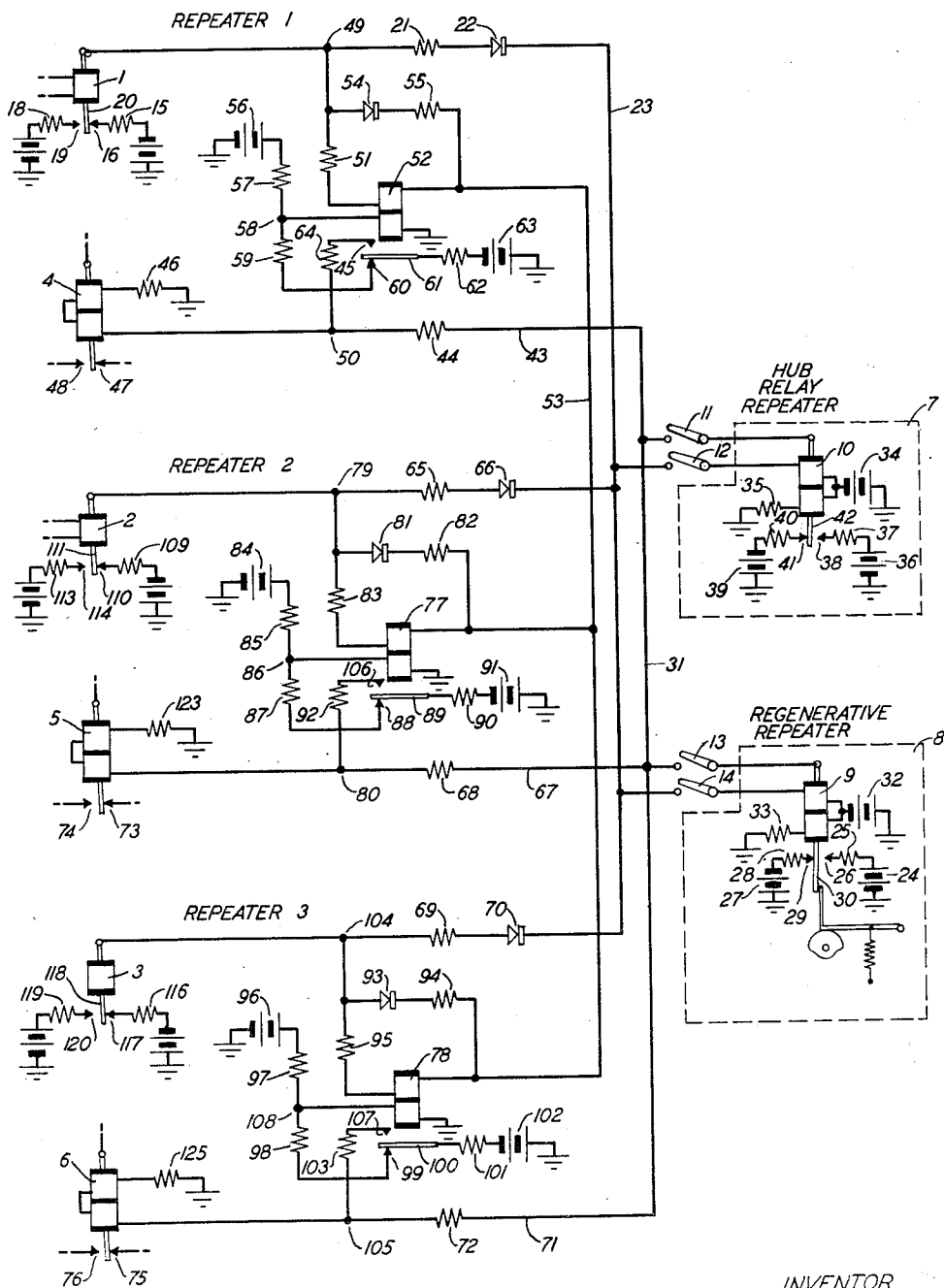
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TELEGRAPH HUB REPEATER

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TELEGRAPH HUB REPEATER

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1

This invention relates to hub telegraph repeaters and more particularly to an improved hub telegraph repeater which may serve either with or without a multiway regenerator.

An object of the invention is the improvement of hub-type telegraph repeaters. Hub-type telegraph repeaters were well known in the art. Such repeaters of a form which are not arranged for multiway regeneration are described, for instance, in Patent 2,056,277, issued to F. S. Kinkad et al. and Patent 2,069,224, issued to G. C. Cummings February 2, 1937. Hub repeaters arranged for multiway regeneration are described in Patents 2,337,496 and 2,392,339 both issued to W. T. Rea on December 21, 1943, and on January 8, 1946, respectively.

The improvements of the present invention consist essentially in the provision in hub-type repeaters of features, namely, (1) a unidirectional shunt around the operating winding of the control relay; and (2) a unidirectional conducting element in each receiving leg. The first of these features is applicable widely in electrical relay circuits. The second may be applied to advantage also in hub-type electronic repeaters to afford advantages in voltage discrimination.

The unidirectional shunt prevents excessive current through the shunted winding of the control relay when the individual repeater with which the control relay is associated transmits a spacing signal toward the hub. Under this condition the operating winding of the control relay is connected in series to a circuit comprising from 2 to 9 shunt branches depending upon the number of individual repeaters interconnected to the single hub. The more branches the greater the current through the single series winding. It has been found that when a heavy current is passed through the winding of a control relay every time the associated repeater transmits a spacing signal toward the hub the relay tends to lose its sensitivity and speed of operation and does not respond properly to currents of normal magnitude of the opposite polarity. The magnitude of the variation in the current passed through the control relay for its two conditions as a result of the use of the unidirectional shunt of the present invention is limited to a ratio of 2 to 1 as the number of individual repeaters is changed from 3 to 10, whereas without the shunt of the present invention the variation is in a ratio of 9 to 1.

The unidirectional conducting element in each receiving leg, provided in the present invention, eliminates the shunting effects of the receiving

2

legs of the other individual repeaters connected to the hub. Without benefit of this feature, the winding of the single hub repeating device is connected in series to a parallel circuit comprising each receiving leg of all of the individual repeaters connected to the hub. The magnitude of the current received from a receiving leg transmitting toward the hub varies depending upon the number of individual repeaters. In order to insure sufficient current to operate the single hub repeating device, the operating winding thereof is required to be of low resistance. The variation in current through the hub repeating device causes a wide variation in its time of response. This in turn reacts on the operating requirement for the control circuit in the individual repeaters.

A feature of the present invention is a unidirectional shunt around the operating winding of the control relay in the individual repeater of a hub telegraph repeater circuit.

A further feature of the invention is a rectifier in series in the receiving leg of each individual repeater in a hub telegraph repeater circuit.

These and other features will become apparent from the following description when read with reference to the associated drawing which taken together disclose a preferred embodiment in which the invention is presently incorporated. It is to be understood that the invention is not limited in its application to the present embodiment but may be applied in other circuits which will readily suggest themselves to those skilled in the art.

Refer now to the drawing. In the drawing three individual hub-type repeaters, repeaters 1, 2, and 3, are arranged so that they may be interconnected through a common receiving hub and a common sending hub, at a first time, when multiway regeneration is not required, to hub relay repeater 7, by closing switches 11 and 12 while switches 13 and 14 remain open, and at a second time, when multiway regeneration is required, to regenerative repeater 8, by closing switches 13 and 14, while switches 11 and 12 remain open.

Repeaters 1, 2, and 3 each has a receiving relay 1, 2, and 3 respectively, and a sending relay 4, 5, and 6, respectively. These sending and receiving relays may be the sending and receiving relays of repeater circuits interconnecting the local hub circuit with telegraph line or subscriber loop circuits.

It will first be assumed that switches 11 and 12 are open and switches 13 and 14 are closed

so as to connect the regenerative repeater 8 into the system. The circuit, assuming switches 13 and 14 closed, is shown in the idle condition. While in operation the armature 30 of the regenerative device 9 does not engage the marking contact 29, as shown, on a transition from spacing to marking until after a delay interval equal in duration to at least one-half of the duration of a signal element. This is to permit the regenerator to be controlled by the middle portion of each incoming signal element to insure accurate determination of its kind, that is whether it be a marking or spacing signal element. The transmitting armature 30 is then locked in position for an interval equal to the length of a standard signal element. This results in a delay between the reception of a signal element by the regenerator and its retransmission. The armature of the regenerating device 9 during actual operation, therefore, will lag the armature of any receiving relay such as armature 20 of relay 1 in repeater 1 by at least half a signal element.

For the condition shown in the drawing the armatures 20, 111 and 118 of receiving relays 1, 2, and 3 in repeaters 1, 2, and 3 are in engagement with their respective marking contacts 16, 110, and 117. Each then connects negative battery through resistances 15, 109, and 116, contacts 16, 110, and 117, armatures 20, 111, and 118, resistances 21, 65 and 69 and rectifiers 22, 66, and 70, respectively, in parallel to the common receiving hub 23, and the path continues through switch 14 and the top winding of regenerative device 9 to negative battery 32. No current flows through the top winding of regenerative device 9 for this condition as each termination of the branches of the circuit is in negative battery of the same magnitude. The armature 30 of regenerative device 9 is maintained in engagement with its left-hand or marking contact by the effect of current flowing from negative battery 32 through the lower winding of regenerative device 9 and resistance 33 to ground.

When the armature 30 of regenerative device 9 is in engagement with its marking contact 29, a circuit may be traced from negative battery 27 through resistance 28, contact 29, armature 30 and switch 13 to transmitting hub 31 from which three parallel sending legs 43, 67 and 71 extend through resistances 44, 68, and 72, windings of relays 4, 5, and 6, and resistances 46, 123, and 125, respectively, to ground. The effect of the current flowing through the windings of relays 4, 5, and 6 maintains their armatures in engagement with their marking contacts 47, 73, and 75, respectively, for this condition.

Each of the individual repeaters is provided with a control circuit, the primary function of which is to prevent the retransmission of signals received by its receiving relay, such as relay 1 in repeater 1, back through the sending relay in the sending leg of the same individual repeater such as sending relay 4 in repeater 1. The control circuits may be traced from junctions 49, 79 and 104 in the receiving legs of repeaters 1, 2, and 3, through resistances 51, 83 and 95 and the top windings of relays 52, 77, and 78 respectively, to a common conductor 53 which connects the right-hand terminals of the windings in parallel. Each of the top windings of relays 52, 77, and 78 is provided with an individual rectifier-resistance shunt. Rectifier 54 and resistance 55 shunts resistance 51 and the top winding of relay 52. Rectifier 81 and resistance 82 shunts resistance

83 and the top winding of relay 77. And rectifier 93 and resistance 94 shunts resistance 95 and the top winding of relay 78. The bottom windings of relays 52, 77, and 78 are connected between ground and junctions 58, 86, and 108 in potentiometers comprising positive batteries 56, 84, and 96, resistances 57, 85, and 97, resistances 59, 87, and 98, contacts 60, 88, and 99, armatures 61, 89, and 100, resistances 62, 90, and 101 and negative batteries 63, 91, and 102, respectively.

No current flows through the top winding of any of the control relays 52, 77, and 78 since each of the connected branches of the circuit in which the windings are included terminates in negative battery of the same magnitude. The effect of the current flowing through each of the bottom windings of relays 52, 77, and 78 maintains the armature of each of these relays in engagement with the respective bottom contact as shown in the drawing for this condition.

It will now be assumed that relay 1 in repeater 1 receives signals. In response to the first spacing signal element, armature 20 of relay 1 will be actuated to engage its spacing contact 19. Positive battery will, therefore, be impressed through resistance 18, contact 19, and armature 20 on the receiving leg of repeater 1 and through the top winding of regenerative device 9, over the path heretofore traced, to negative battery 32. Rectifier 22 and the corresponding rectifier in each receiving leg are so poled that they present a low resistance to current from positive battery connected to their left-hand terminals and practically infinite resistance to current from negative battery connected to their left-hand terminals. The current from positive battery on the spacing contact of relay 1 therefore flows freely through rectifier 22 and through the top winding of regenerative device 9 actuating the armature 30 of regenerative device 9 to engage with its right-hand or spacing contact 26 after the delay interval has elapsed. The receiving leg of repeater 2 and of repeater 3 do not shunt the receiving leg of repeater 1 as hub 23 becomes positive and rectifiers 66 and 70 do not pass current freely when positive potential is applied to their right-hand terminals. This is one of the important aspects of the present invention since the connection of a rectifier properly poled in each receiving leg prevents the shunting effect of the other receiving legs of the individual repeaters connected into the hub when a particular receiving leg is transmitting toward the hub. It is particularly pointed out that at times as many as 10 individual repeaters are connected into a hub. The current transmitted through the operating winding of the regenerative device would therefore vary dependent upon the number of individual repeaters connected to the hub without benefit of the rectifiers 22, 66, and 70. This would adversely affect the operation of the system.

When the armature 30 of the regenerative device 9 engages its spacing contact 26, positive battery 24 is connected through resistance 25 and spacing contact 26 to armature 30 from where the circuit has been traced through the common sending hub, the sending leg in each individual repeater and the winding of the sending relays 4, 5, and 6 in parallel. The armatures of sending relays 5 and 6 will be actuated to engage their spacing contacts 74 and 76, respectively, to transmit the spacing signal over the connected lines to the distant stations. Since the signal is assumed to have originated in repeater 1, it is

important that it should not be retransmitted by sending relay 4 in the same repeater. How this is prevented will now be explained.

When positive battery is impressed through resistance 18, spacing contact 19 and armature 20 on the receiving leg of repeater 1, current flows through the control circuit heretofore traced from junction 43 through the top winding of relay 52 to common branch 53 and then in parallel from right to left through the top windings of relays 77 and 78 and resistances 83 and 95 to negative battery connected to the marking contacts of relays 2 and 3, respectively. In response to this the armature 61 of relay 52 is actuated to engage its contact 45. This establishes a circuit from negative battery 63 through resistance 62, armature 61, contact 45, resistance 64, junction 50, winding of sending relay 4, and resistance 46 to ground. This holds the armature of relay 4 on its marking contact 47. When, after the duration of a half signal element, a positive impulse is transmitted from the spacing contact of regenerative device 9, the potential of junction 50 is maintained negative to maintain the armature of relay 4 on its marking contact. This is effected by a proper choice of the magnitude of the resistances and batteries of the branches connected to the winding of relay 4.

The instant armature 61 breaks from contact 60 the direction of the flow of current through the bottom winding of relay 52 is reversed so that its effect now tends to urge the armature of relay 52 to engage contact 45. When the armature 20 of relay 1 reengages its marking contact 16 no current will flow through the top winding of relay 52 and its armature will be maintained in engagement with its contact 45 by the effect of the current in the bottom winding of relay 52, to continue to maintain the armature of relay 4 on its marking contact 47 as long as transmission continues from relay 1.

When relay 1 stops transmitting toward the hub the armature of relay 52 will continue to engage contact 45, due to the effect of the current in the bottom winding of relay 52, so that the armature of relay 4 will remain on its marking contact 47 under the influence of negative battery 63. If now the receiving relay in some other repeater, receiving relay 2 in repeater 2, for instance, starts to transmit toward the hub, it is necessary to disconnect the armature 61 of relay 52 from contact 45 so that the armature of relay 4 will be free to follow the signals transmitted from the regenerative device. This is performed in the following manner.

When the armature 111 of relay 2 engages its spacing contact 114, positive battery is impressed through the top winding of relay 77 on common conductor 53. Attention is called to the fact that repeater 1 is now assumed to be idle and therefore the armature 28 of relay 1 is in engagement with its marking contact as shown. For this condition then positive battery is connected to the right-hand terminal of relay 52 and negative battery to the left-hand terminal. Since when the polarities of the batteries connected to these terminals were assumed to be reversed the effect of the current in the top winding of relay 52 tended to actuate the armature 61 of relay 52 toward contact 45, the reverse effect, due to the reversed polarities of the batteries, now tends to actuate the armature 61 toward its contact 60. Further this effect is dominant over the effect of the current in the bottom winding of relay 52, so that the armature 61 will be actuated to engage

contact 60. The instant armature 61 breaks from contact 45 the holding condition on the armature of relay 4 is terminated so that relay 4 is free to follow the regenerated spacing signal.

In response to the first spacing signal from relay 2, relay 77 will actuate its armature 89 to engage its contact 106 in order to maintain the armature of relay 5 on its marking contact 73 where it will be maintained as long as relay 2 of repeater 2 continues to transmit toward the hub and until some other individual repeater starts thereafter to transmit. This should be apparent from the foregoing.

In the foregoing, to facilitate an understanding of the operation, the assumption was made that at the outset all three control relays 52, 77 and 78 were in the condition indicated on the drawing. Normally, as should be apparent from the foregoing, the armature of the control relay associated with the repeater which last transmitted toward the hub will be in engagement with its upper contact and the armature of the associated sending relay 4, 5 or 6 will be maintained on its respective marking contact under the influence of its particular control relay.

Attention is particularly called to the rectifier resistance shunt about the top winding of each control relay, such as rectifier 54 and resistance 55 shunting the top winding of relay 52 in series with resistance 51, in repeater 1. When any individual repeater is transmitting toward the hub, the top winding of the control relay in that particular repeater is, for the spacing condition, connected in series to a group of parallel branches, each branch including the top winding of a control relay such as that of relays 77 and 78 in repeaters 2 and 3. The number of branches depends upon the number of individual repeaters connected to the hub. If there are ten repeaters, there will be nine parallel branches each extending through the top winding of the control relay in some one of the nine other repeaters all connected in series with the winding of the control relay in the individual repeater which is at the moment transmitting toward the hub. As a result of this, the effective resistance of the nine-branched shunt will be quite low. Each time a spacing signal is transmitted toward the hub, if the rectifier shunt is not employed, an inordinately large current will flow through the top winding of the control relay in the individual repeater which is transmitting toward the hub. The magnitude of the current would be widely variable depending upon the number of individual repeaters employed.

When another individual repeater starts to transmit as explained in the foregoing, it is required that the control relay in the repeater which last transmitted be unlocked. Because of the parallel arrangement of the top windings of the control relays for this condition the current through each if many are employed will be relatively small.

The control relay is required to operate quickly on any transition, to lock the sending relay on one transition to avoid retransmission, and to unlock the sending relay on the other transition to avoid signal clipping, particularly when the hub relay repeater is employed and there is no delay. The rectifier resistance shunt tends to equalize the magnitude of the current for a variable number of individual repeaters for each transition.

When the hub relay repeater 7 is employed, as mentioned above, switches 11 and 12 are closed and switches 13 and 14 are opened. The relay

10 serves in the stead of regenerative device 9. Except for the absence of the cammed locking device shown below the regenerative device 9, which introduces the delay when the regenerative device 9 is employed, relay 10 operates in substantially the same manner as does regenerative device 9. The armature of relay 10 is maintained on marking contact 41 by the effect of negative battery 34 flowing through resistance 35 to ground. Negative battery 39 is connected through resistance 40 and contact 41 for marking. The armature of relay 10 is operated to spacing contact 38 by the effect of negative battery 34 flowing through switch 12 to whichever receiving leg has positive battery applied to it by an incoming spacing signal. Positive battery 36 is connected through resistance 37 and contact 38 for spacing.

What is claimed is:

1. In a telegraph hub repeater system, a plurality of individual repeaters interconnected through a hub, a control circuit individual to each of said repeaters, a control relay in each of said control circuits, an operating winding on each of said relays, a circuit path establishable for a first transmitting condition through one of said windings in series with all of the others of said windings in parallel, and a rectifier shunting said one winding, said rectifier so poled as to pass current for said first condition.

2. In a telegraph hub repeater system, a plurality of individual repeaters interconnected through a hub, a control circuit individual to each of said repeaters, a control relay in each of said control circuits, an operating winding on each of said relays, each of said windings having a corresponding terminal directly interconnected one to another and a potential polarity sensitive unidirectional shunt individual to each of said windings.

3. A plurality of energizing windings, said windings each having a first corresponding terminal connected to a common electrical point and a second corresponding terminal connected to individual points, individual switching means connected to said individual points, said switching means arranged to apply a potential of a uniform first polarity and a uniform magnitude simultaneously to each of said individual points for a first condition at a first time, any one of said switching means arranged to apply a potential of a second polarity to its particular individual point at a second time while the others of said switching means continue to apply potential of said first polarity to their respective individual points for a second condition, and a rectifier

shunting each of said windings, said rectifier so poled as to pass current of said second polarity.

4. In a direct-current telegraph hub repeater system, a plurality of individual hub-type repeaters, a receiving hub, a sending hub, a receiving leg in each of said repeaters connected to said receiving hub, a sending leg in each of said repeaters connected to said sending hub, control means in each of said repeaters for simultaneously directing signals generated in any of said receiving legs through the sending legs of all of said repeaters other than the sending leg of the repeater in which said signals are generated, and an individual rectifier connected in each of said receiving legs.

5. In an electrical relay circuit, at least three relays, a winding on each, said windings interconnectable in variable series-parallel arrangements subjecting individual ones of said windings to the flow of currents of different magnitudes for the different connections, and a rectifier shunting each of said windings to tend to equalize the current flowing through each of said windings for said different connections.

6. In a telegraph hub repeater system, a plurality of individual repeaters, a receiving leg in each of said repeaters, a hub, each of said legs connected individually to said hub, an individual rectifier connected in series in each of said legs, battery of a uniform first polarity impressible on each of said legs simultaneously for a first signaling condition, each of said rectifiers so poled as to present an inordinately high resistance for said condition, battery of a uniform second polarity, opposite from said first polarity, impressible on any one of said legs for a second signaling condition, while battery of said first polarity remains impressed on all others of said legs, said rectifiers in said other legs minimizing the shunting effect of said other legs while said second condition prevails.

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