To all whom it may concern:

Be it known that we, CLARENCE E. LOMAX and RUDOLPH F. STEHLIK, citizens of the United States, and residents of Chicago, in the county of Cook and State of Illinois, have jointly invented certain new and useful Improvements in Repeaters for Automatic Telephone Systems, of which the following is a specification.

This invention relates in general to Repeaters for automatic telephone systems, but more particularly to Repeaters of the so-called two wire type; and the object of the invention, broadly stated, is to provide a new and improved impulse or interruption correcting means which becomes effective in certain cases where the Repeater fails to accurately reproduce the received interruptions.

More in detail, the Repeater is provided with a line relay which responds to interruptions in the incoming circuit in the usual and well known manner, and repeats these interruptions in the outgoing circuit. Under ordinary conditions this operation is unmodified and takes place in exactly the same manner as in ordinary Repeaters of this character. It may happen, however, due to certain line conditions affecting the incoming circuit, which will be explained more fully hereinafter, that the line relay fails to respond accurately, with the result that the repeated interruptions are of too long duration; and there is provided, therefore, a compensating relay and suitable circuit arrangements which become effective in such cases to prime the line relay of the switch being operated over the outgoing circuit, thereby compensating for the long interruptions by causing the line relay to energize a little more quickly responsive to the impulses which follow such interruptions.

Since the correcting means will compensate for long interruptions due to failure in the Repeater, it will of course, also correct or compensate for impulses which are an accurate reproduction of the received impulses but which are too long because the received impulses are too long to start with.

The particular means employed in attaining the foregoing ends and the operation thereof will be fully described hereinafter, reference being had to the accompanying drawing, which shows diagrammatically the apparatus and circuits involved.

The apparatus to the left of the vertical dot and dash line, indicated as R, is the improved type Repeater and is located in a local office, while the apparatus to the right of the vertical dot and dash line, indicated as E, is a selector switch and is located in a distant office. The Repeater R consists essentially of a repeating coil RC, high resistance 28, and a plurality of relays, which includes the electro-polarized shunt field relay 12 and compensating relay 15, while the selector E consists essentially of a plurality of relays and magnets and is mechanically of the well known vertical and rotary type in which the bank contacts are arranged in horizontal rows or levels. Since selectors of this description are well known they will not be described in detail.

Having briefly explained the purpose of the invention and the apparatus involved in carrying it out, the operation of the equipment may now be explained more in detail. For this purpose it will be assumed that a telephone connection has been extended to Repeater R and that the bank contacts 2, 3 and 4 are those of a selector switch, which switch has been operated from a calling substation by way of a line switch, while the trunk line conductors 81, 82 and 83 extend to a connector switch which has access to the called substation, all of which is shown, for example, in U. S. Letters Patent No. 1,344,210 to Richardson, dated June 22, 1920.

When the selector bank contacts 2, 3 and 4 are seized a circuit is closed as follows: from ground, lower winding of line relay 13, lower left hand winding of repeating coil RC, normally closed contact controlled by armature 17, bank contact 2, direct current bridge of the calling substation (not shown), bank contact 4, normally closed contact controlled by armature 16, upper left hand winding of repeating coil RC, to upper winding of line relay 13 and grounded battery. Relay 13, upon energizing, closes a circuit at armature 19 for release relay 14. Upon energizing in turn, relay 14 completes a holding circuit at its armature 21 for the preceding switches in the usual well known manner and closes at armature 22 a circuit for compensating relay
15, which relay, however, will not energize at this time due to being shunted out by armature 19 and its working contact. In addition to closing a circuit for release relay 14, the line relay 13 closes at armature 20 a bridge across the conductors 31 and 32 of the trunk line extending to the distant office; and there terminating in the incoming selector E. This bridge may be traced from conductor 31 by way of the upper right hand winding of the repeating coil RC, the left hand winding of shunt field relay 12, the lower right hand winding of the repeating coil RC, armature 20 and its working contact to conductor 32. Upon the closure of this bridge the line relay 41 of the selector E is energized by way of armatures 61 and 64 and their resting contacts and completes a circuit for the slow acting release relay, thus preparing the switch to receive the dialling impulses in the usual well known manner.

Continuing now with the operation at the repeater R, when the bridge is closed across the conductors 31 and 32, to include the left hand winding of shunt field relay 12, this relay is not operated at this time due to the fact that there is a closed magnetic circuit through the right hand core of this relay and the flux is diverted away from the armature. When the release trunk conductor is grounded at armature 21 a circuit is also closed for the right hand winding of shunt field relay 12. This relay still remains unoperated as the direction of current flow through the windings is such that the polarity of the magnet cores are opposed in sign; that is, if the upper end of the right hand core is positive, the upper end of the left hand core will be negative. Thus, under normal conditions before the called party answers, the magnetic flux generated will flow through the two magnet cores in series and will not affect the armature of the relay.

The calling subscriber may now operate his calling device in accordance with the next digit in the desired number, whereby producing a corresponding number of interruptions in the circuit of the line relay 13 of the repeater R. In response to these interruptions of its circuit, relay 13 deenergizes momentarily a corresponding number of times and at each deenergization opens the circuit of relay 14 and closes a circuit for relay 15 at armature 19, thus removing the shunt from relay 15 and establishing one for relay 14. Relay 14, due to being shunted, becomes slow acting and holds up during the impulse sending interval. Relay 15 is of comparatively high resistance and has a stiff spring adjustment so that its operation is dependent upon the length of time its circuit is held closed, as will be explained hereinafter. In addition to operating armature 19, the line relay 13 opens at armature 20 the bridge across the trunk conductors 31 and 32 the same number of times as the digit dialled, whereby a corresponding number of interruptions are produced in the circuit of the line relay 41 of the selector E. In response to these interruptions the selector switch operates to raise its wipers step by step and rotate in to select an idle trunk line, such as the one numbered 81, 82 and 83, in the usual well known manner.

As mentioned above the operation of relay 15 depends upon the length of time its circuit is held closed. If the line over which the dialling is done is short or of low resistance, the line relay 13 will deenergize a little slowly when its circuit is interrupted, due to being thoroughly saturated, and will energize again quickly, due to the comparatively low resistance of the dialling line. From this it will be seen that relay 15 is energized for a short time only and as a result will not operate. If, however, the line over which the dialling is done is long or of high resistance, the line relay 13 will deenergize quickly when its circuit is interrupted, due to not being thoroughly saturated, and will energize again slowly, due to the high resistance of the dialling line. Under these conditions, therefore, it will be seen that relay 15 is energized for a longer period than in the case of a short line and will operate, as its springs are tensioned so as to operate beyond a predetermined time interval.

When relay 15 does operate it closes at armature 24 a bridge across the conductors 31 and 32 by placing a shunt around armature 20, which shunt includes the high resistance 23. This resistance is high enough to prevent the line relay 41 of the selector E from operating but allows enough current to pass to prime said relay for quick action when armature 20 is pulled up after the first interruption. At the same time armature 20 is pulled up by relay 13 the operating circuit of relay 15 is opened at armature 19, whereupon relay 15 falls back and the high resistance shunt around armature 20 is opened at armature 24. This operation obtains for each interruption in the circuit of the line relay 13 and thus it will be seen that the extra long interruptions produced in the circuit of the line relay of selector switch E are corrected or compensated for.

The calling subscriber may now operate his calling device in accordance with the last two digits in the desired number, whereupon the repeater R repeats the impulses to a connector switch (not shown), causing them to be corrected if over a predetermined length as described above. The connector switch raises its wipers step by step to the desired level and rotates them in step by step to the desired bank contacts, where-
upon the called subscriber is rung in the usual well known manner.

When the called subscriber answers the call by lifting his receiver the connector switch operates to stop the ringing and reverse the current flow through the left hand winding of the electro-polarized shunt field relay 12 of repeater R. The polarity of the left hand core is reversed and the magnetic flux produced will necessarily flow through the two cores of the relay in parallel and through the armature of the relay and the heel piece (not shown). Accordingly, armature 18 is attracted and a circuit is completed for the reversing relay 11, which is at once energized in order to reverse the direction of current flow in the trunk conductors 2 and 4 and in the calling subscriber's line. This latter reversing operation, although of no particular utility in connection with the apparatus shown herein, is required on occasion for the purpose of operating a meter, or other device, and since it is ordinarily provided for in working exchanges the circuits are so illustrated herein.

The calling and called subscribers may now converse and upon completion of the conversation will hang up their receivers.

When the calling subscriber hangs up his receiver the circuit of the line relay 13 of the repeater R is broken. By the deenergization of relay 13 the circuit of release relay 14 is broken. Upon deenergizing, relay 14 removes ground from the holding circuit extending back to the preceding switches, whereupon these switches will re-strike to normal in the usual well known manner. As a further result of the deenergization of relay 13, the energizing circuit for the line relay of the connector (not shown) is broken, whereupon the release relay is deenergized and ground is removed from the holding circuit of the selector E and a circuit is closed for the release magnet of the connector. These switches are then also restored to normal in the usual well known manner.

Having described our invention, what we consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What is claimed is:

1. In an impulse repeater for automatic telephone systems, incoming and outgoing circuits, a line relay responsive to interruptions in the incoming circuit, interrupter contacts on said line relay for repeating such interruptions into the outgoing circuit, a high resistance, and means operated automatically near the end of each interruption to connect said resistance in shunt of said contacts.

2. In an impulse repeater for automatic telephone systems, incoming and outgoing circuits, a line relay responsive to interruptions in the incoming circuit, interrupter contacts on said line relay for repeating such interruptions into the outgoing circuit, a high resistance, and means operated automatically near the end of each interruption to connect said resistance in shunt of said contacts.

3. In an impulse repeater for automatic telephone systems, incoming and outgoing circuits, a line relay responsive to interruptions in the incoming circuit, interrupter contacts on said line relay for repeating such interruptions into the outgoing circuit, and means for automatically shunting said contacts near the end of any interruption which exceeds a predetermined length.

4. In an impulse repeater for automatic telephone systems, incoming and outgoing circuits, a line relay responsive to interruptions in the incoming circuit, interrupter contacts on said line relay for repeating such interruptions into the outgoing circuit, and a compensating relay controlled by said line relay for shunting said contacts whenever they are held open for longer than a certain standard time interval.

5. The combination, with a selector switch and a repeater, said repeater being provided with means responsive to received interruptions for repeating such interruptions into the line relay circuit of the selector, or means for automatically priming the line relay whenever a repeated interruption exceeds a given length.

6. The combination, with a selector switch and a repeater, said repeater being provided with means responsive to received interruptions for repeating such interruptions into the line relay circuit of the selector, or means for automatically priming the line relay whenever a repeated interruption exceeds a given length, said priming means comprising circuit arrangements for setting up a small flow of current through the line relay to cause the same to energize more quickly when the interruption is terminated.

7. In a telephone system, a trunk line divided into two sections, the second section terminating in a line relay in an automatic switch, and an impulse repeater joining the two sections of said trunk line, said repeater comprising a relay controlling the continuity of the second section, and a电路 correct time relay adapted to control the length of impulses in said automatic switch by partly energizing said line relay through the medium of a high resistance shunt.

In witness whereof, we hereunto subscribe our names this 18th day of October, A. D. 1923.

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