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UNATTENDED MECHANICAL REPEATER

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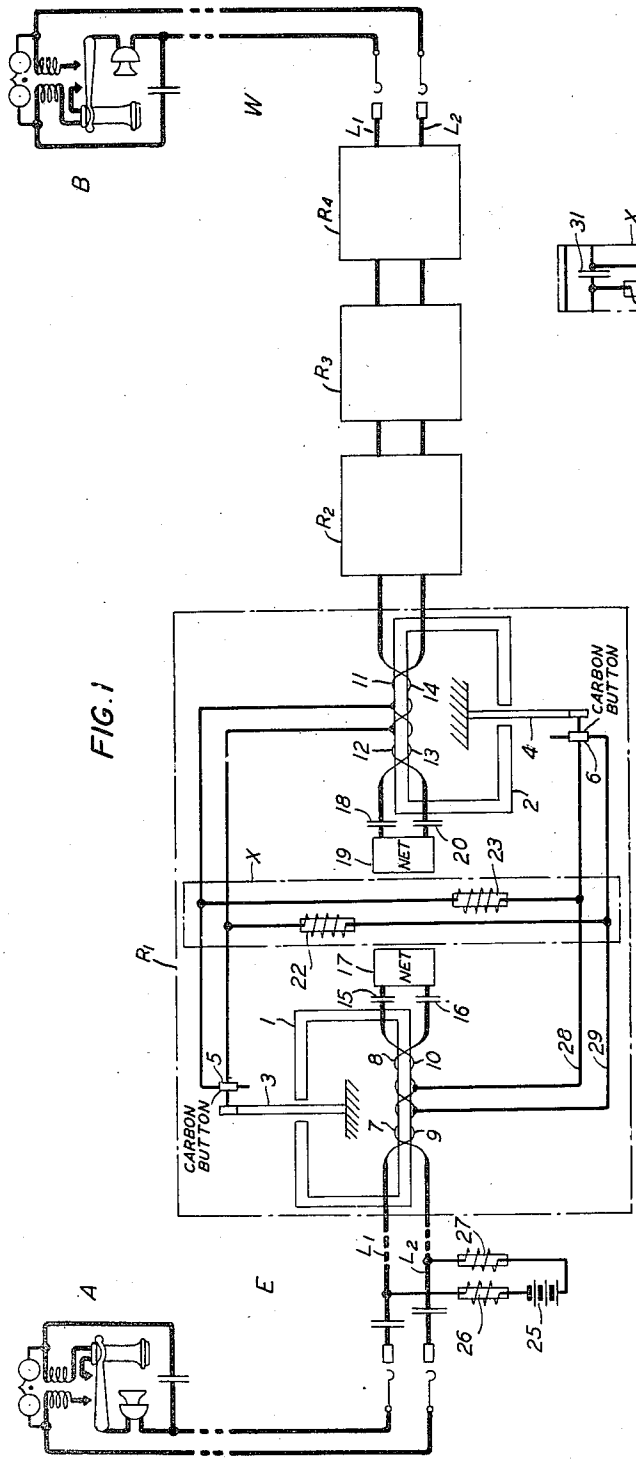

FIG. 1

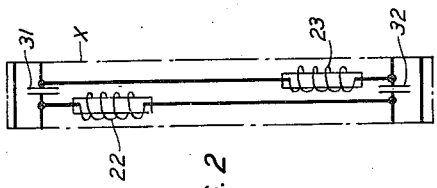

FIG. 2

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UNATTENDED MECHANICAL REPEATER

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7 Claims. (Cl. 179—170)

This invention relates to a telephone transmission system in which speech or other signals transmitted over a transmission line of considerable length are amplified at a number of intermediate points, in order, to compensate for the attenuation of the line. More particularly it relates to a system of this sort in which amplifiers of the so-called mechanical type are employed and the energy for the operation of all such amplifiers is fed over the line conductors through successive amplifiers or repeaters.

The mechanical type of amplifier was proposed a number of years ago and one type thereof is disclosed in Shreeve Patent No. 791,655, June 6, 1905. About the time that devices of this sort were brought to a practical stage of development the vacuum tube type amplifier was introduced and because of the larger amplifying factor and high fidelity of the vacuum tube it has largely superseded the mechanical type of amplifier in commercial installations.

One objection to the use of the mechanical type was that, because of its low amplifying factor, a large number were needed spaced along the line at short intervals and as they each required local battery this meant a large number of attended repeater stations. However, in accordance with the present invention, this objection is obviated by supplying battery or energy over the transmission line itself so that a large number of unattended mechanical repeaters can be used, since devices of this type may be in the form of very simple and compact apparatus suitable for mounting in a container either on the poles carrying the transmission line or in the case of underground cable, adjacent to such cable. This close spacing is not a limiting factor. Furthermore, owing to the introduction of better magnetic materials and improvement in the microphone construction and the general technique applying thereto, it has become possible to construct mechanical type repeaters which, as far as quality of reproduction is concerned, compare very favorably with the vacuum tube type, although the amplifying factor may be somewhat lower.

It has previously been proposed in connection with submarine cable circuits to supply repeaters of the vacuum tube type with direct current energy over the conductors of the cable but here the problem is quite different from that with which the present invention is concerned because of the difference in the circuit requirements of the vacuum tube repeater and the mechanical repeater. The vacuum tube repeater requires both filament and plate potentials and furthermore the plate potential must be high as the plate circuit is a high impedance path. In the mechanical type of repeater the incoming and outgoing circuits are separate and distinct, the action between the two circuits being mechanical rather than of an electrical nature. On the other hand, it is necessary to supply the microphone part of the mehanical repeater with direct current energy in order that such part of the repeater and generally the outgoing part can perform its function. Also the microphone is a low impedance device and high battery potentials are not required. With the vacuum tube repeater, the battery supply is fed around the repeater in a by-pass circuit whereas in accordance with the present invention battery is fed through the windings of the repeater element to similar windings of successive repeaters providing a simple and economical arrangement involving the minimum amount of equipment at each station. In accordance with a feature of the invention this is accomplished by utilizing certain windings of the usual hybrid or balancing network as the energizing windings of the repeater.

The various objects and features of the invention and the preferred manner of carrying it out will be better understood from the following specification, including the drawing forming a part thereof, in which Fig. 1 is a diagrammatic representation of a two-way, two-element repeater installation, and Fig. 2 shows a modification in the battery supply circuit.

Referring to Fig. 1, conductors of the transmission line are indicated as L1 and L2 extending between two telephone stations A and B which may be associated with the transmission line through the usual switch or plug and jack connection. Included in the transmission line in tandem are a number of mechanical type repeaters indicated as R1, R2, R3 and R4 and there may be as many of such repeaters of course as are necessary to compensate for the attenuation of the particular transmission line. As these repeaters are indentical in construction and circuit arrangement, the circuit arrangement of only one of them, R1, is shown in detail. These repeaters are of the two-way, two-element type in that they repeat voice currents in either direction and, for convenience in description the transmission from station A to B will be considered as east-west transmission and from B to A as west-east. At repeater stations such as R1 there are provided two incoming repeater elements, each operating an output element. The incoming elements comprise the magnets 1 and 2, actuating armatures 3 and 4 respectively. The output elements are of the microphone type and may be carbon buttons indicated diagrammatically as 5 and 6. Each input element is provided with four energizing windings 7, 8, 9 and 10 and 11, 12, 13 and 14, respectively. The windings 7 and 8 are connected in series with the transmission line, conductor L1, and through condenser 15 to a balancing artificial line 17 and conductor L2 is connected through windings 9

and 10 in series and condenser 16 to the balancing line 17. Similarly the windings 11 and 12 are connected through the condenser 18 to the network 19 and the windings 13 and 14 through condenser 20 to the network 19. At the mid-point between windings 7 and 8 and 9 and 10 and in series relation therewith a microphone 6 is associated with the line conductors L1 and L2 and similarly the microphone 5 is associated with the mid-points between the windings 11 and 12 and 13 and 14 respectively. There is bridged across these two circuits through retard coils 22 and 23 a path for direct current to the microphone elements, and at one end of the transmission line there is associated with the conductors L1 and L2 a source of direct current potential 25 through retard coils 26 and 27.

It will be apparent to one skilled in the art that the coils 7, 8, 9 and 10 together with the balancing artificial line 17 form a network of the Wheatstone bridge type which is well known in the art as a hybrid coil. A similar arrangement is afforded, of course, by the windings 11, 12, 13 and 14 and the balancing line 19. The battery for supplying energy to the microphone or variable impedance elements of each of the repeaters is supplied by the battery 25 over a circuit which may be traced from the battery 25, impedance coils 26 and 27, conductors L1 and L2, windings 7 and 9, conductors 28 and 29, microphone 6 and through retard coils 22 and 23 to microphone element 5. Energy for similar elements of succeeding repeaters passes over conductors 28 and 29 through retard coils 23 and 22 through the windings 11 and 14 to repeaters R1, R2, R3, R4, etc.

The operation of the line in transmitting telephone signals is as follows:

Considering first transmission from east to west, voice currents generated at substation A in the usual manner pass over the circuit comprising line L1, through the coils 7 and 8 in series, balancing network 17, through the coils 9 and 10 in series, and through conductor L2, back to substation A. These currents set up a magnetic field which operates the armature 3 and varies the impedance of the microphone 5 to produce amplified impulses in the circuit of such microphone. These impulses pass through the mid-points between the windings 11, 12 and 13 and 14 but as these windings are balanced against each other they will not affect the armature 4 and will pass to the electromagnetic windings of the next repeater in the series. In transmitting from west to east the reverse process takes place and the armature 4 becomes active to actuate the microphone 6 which is connected to neutral points between the windings 7, 8, 9 and 10 and thence to the substation A. The retard coils 22 and 23 form a high impedance path to the voice currents and a low impedance path to the direct current of the battery feed preventing reaction between the two output circuits of the repeater.

In the repeater station shown in Fig. 2 the carbon buttons are connected in series with the battery instead of in parallel as in Fig. 1 condensers 31 and 32 are blocking condensers. Depending on such factors as the gauge of the line wire, length of circuit, carbon button resistance or other factors there may be occasions in which the series connection would be preferred over the parallel connection. The principle of operation is otherwise the same.

It will be obvious that the general principles herein disclosed may be embodied in organizations differing from that illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a telephone transmission line including a plurality of repeaters in tandem, said repeaters comprising electromagnetic input elements operating variable impedance output elements, means for feeding electrical energy to all said output elements over the conductors of the transmission line through the windings of the electromagnetic input elements.

2. In a telephone transmission line including a repeater comprising an electromagnetic input element operating a variable impedance output element, means connected across the conductors of said line to feed electrical energy to said output element through the windings of the said input element.

3. In a transmission line, a repeater, and means for associating said repeater with said line comprising hybrid coils having windings in series with said line and with balancing networks, characterized in this that the series windings of said coils form the energizing windings of the repeaters.

4. In combination, an electromechanical repeater having an electromagnetic input element and a variable impedance output element, a hybrid coil comprising a plurality of windings which form the energizing windings for said input element, said variable impedance output element being bridged across said hybrid coil.

5. A telephone system line comprising a plurality of repeater sections in tandem, a repeater inserted between adjacent repeater sections, said repeater comprising a variable resistance and an actuating coil therefor, said coil being serially included in the line, means connecting said variable resistance in bridge of said coil and in repeating relation to the opposite line section, and means for supplying direct current to said variable resistance from the distant end of one of said repeater sections in series over the line conductors thereof and through said connecting means.

6. A telephone system comprising a line, a repeater connected to said line at a point between the terminals of the line, said repeater being of the mechanical type having a variable impedance element, a coil for activating the repeater element, a circuit including the repeater element in bridge of said coil at the center point of the coil, and means supplying direct current from a terminal of said line over the line conductors and to the repeater element by way of said circuit.

7. In a two-way, two-wire line, divided into repeater sections and carrying signal currents, an electromechanical repeater composed of two identical structures one for each direction of transmission, each having a variable impedance output element and an electromagnetic input element having energizing windings thereon arranged as a hybrid coil, one pair of the end terminals of said coil connected to one repeater section, the other pair to a balancing network, the bridge points of said coil connected to the output element of the other structure, a source of direct current connected to the far end of one of said repeater sections through retard coils, each pair of repeater output elements connected together through retard coils, whereby direct current is supplied to all repeater output elements.

HERMAN A. AFFEL.