

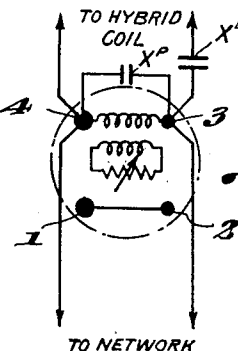
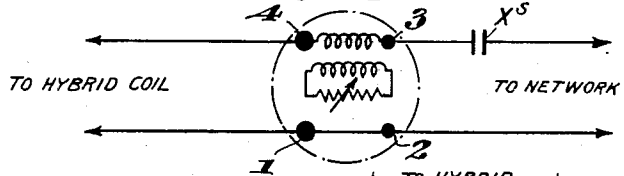
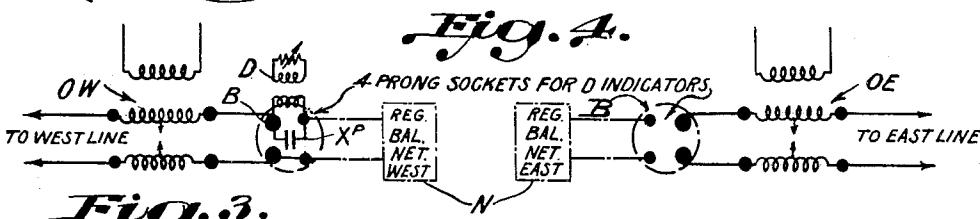
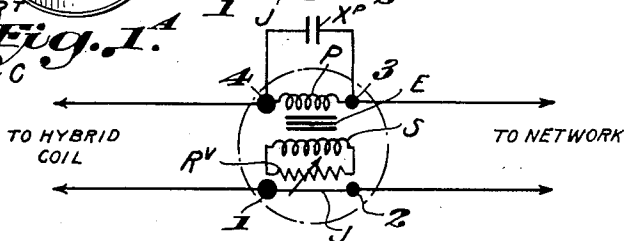
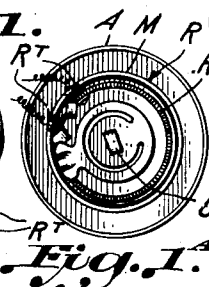
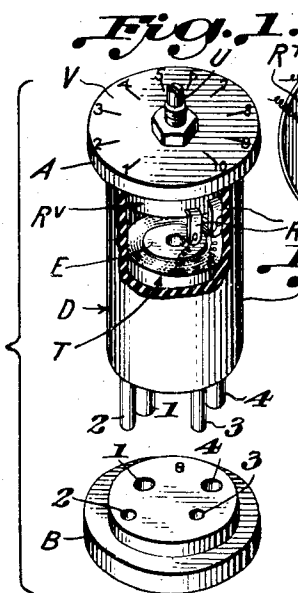
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2,259,788

REPEATER FOR TELEPHONE SYSTEMS

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UNITED STATES PATENT OFFICE

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REPEATER FOR TELEPHONE SYSTEMS

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6 Claims. (Cl. 179-170)

This invention relates to improvements in voice current amplifiers for long distance telephone lines and more particularly to improving the performance thereof which embodies the incorporation of an adjustable inductor to improve the balance and therefore increase both gain and stability of all makes of voice repeaters using so-called "hybrid" coils as output transformers.

Nearly all telephone repeaters in commercial use are of the so-called general type known as "22," all of which employ transformers known as "hybrid" coils, the principle involved being similar to the well-known "Wheatstone bridge" theory, in which repeater's stability or freedom from "howl" depends upon the degree of balance between the telephone line proper and an artificial line or "network" designed to balance against the line at all frequencies within the voice or audio range, usually 200 to 3000 C. P. S.

Even after all constants of capacity resistance and inductance of the line have been carefully analyzed in theory to produce an electrical balance in the artificial line or "network," there is often encountered in actual service some irregular electrical "lump" that fails to balance-out, resulting in limitation of repeater gain, lack of stability, inferior quality of transmission; any one or two or all three factors may be involved.

The primary object of this invention, therefore, is to provide a variable inductor, preferably in the form of a transformer, whose secondary controls not only the inductance of the primary but also deliberately impairs the "Q" and changes the phase-angle of the currents transversing the primary. By means of this device, it is possible to "match" the offending frequency peaks, dips or other electrical conditions in the repeated line by means of this control added to the network.

In general, therefore, the object of the invention is first, to provide a variable balance against not only normal line inductance but also against inductance factors often introduced by various kinds of "wound apparatus," connected to the line. Second, to provide a method (in conjunction with external condensers) of setting up either a broad or narrow-band tuned circuit to balance out some "lumpy" resonant peak or dip in a line which is not electrically smooth throughout the audio band; third, to provide an economical and practical method of balancing any voice repeater against carrier-line filters at the same location. This applies particularly where a voice repeater is installed in conjunction with either a carrier repeater or a set of intermediate line

filters used to by-pass the carrier channel around the voice-repeater.

Another object of the invention is to provide such an inductor as an accessory in the form of a transformer, for convenience, enclosed within a "plug-in" housing arranged to be mounted in a socket designed to receive prongs and make the necessary electrical connections.

A further object of the invention is to provide such a variable induction accessory in the form of a transformer having a core with low hysteresis and eddy current losses, adapting it for operation at all frequencies, particularly within the audio range for use in telephone circuits.

A still further object of the invention is to provide such an inductor in the form of a transformer having a variably shunted secondary which has been found to meet with major success and to be the most efficient form of variable inductor in such telephone repeater circuits.

Other objects and advantages of my invention will appear in the following specification in conjunction with the accompanying drawing forming a part thereof, wherein,

Figure 1 is a perspective view of an inductive device and connector base socket therefor in separated relation, parts of the casing being broken away to show a practical form and arrangement of the elements therein.

Figure 1^A is a bottom plan view of the casing cover of the inductive device shown in Fig. 1.

Figure 2 is a diagram of a preferred arrangement of circuits of the inductive device illustrated in Figure 1.

Figure 3 is a diagram of a balanced circuit arrangement of the inductive device illustrated in Figure 1.

Figure 4 is a simplified diagram of voice repeater having hybrid transformers and arranged for receiving inductors for balancing the networks in accordance with my invention.

Figures 5, 6, 7, and 8 are fragmentary diagrams illustrating various methods of application of the inductive device to networks in accordance with my invention.

Referring to the drawing, a practical form of the inductive device is shown in Figure 1, generally designated D, an embodiment of which as produced for commercial practice of the invention is presented herewith as a model forming a part of this application. The construction of this inductor element is illustrated in Figures 1 and 1^A of the drawing and described as follows:

For convenience the electrical elements of inductor D are housed in a "Bakelite" or similar

composition casing C having four plug-in prongs 1, 2, 3, 4 which are receivable in a conventional type of socket B, a pair of which sockets may be mounted on or incorporated in terminal strips of a voice repeater as diagrammatically indicated at BB in Figure 4.

The casing C houses the inductor element comprising a two (or three) winding transformer T having a low loss magnetic core E of the "dust core" type and on the inner face of the cover member A which is secured to the upper end of casing C is mounted a variable rheostat R^V. As shown in Fig. 1^A this rheostat R^V comprises a circular wire wound resistance element R^E having terminals R^T connected with the terminals of the secondary winding of transformer T. In the construction as shown the rheostat has one of said terminals R^T connected with an end of the resistance winding R^E while the other terminal R^T is connected with a metallic shield M, and thus electrically with the variable contact element L mounted on a rotatable control shaft U which extends through cover member A. As shown in Fig. 1 the end of shaft U is kerfed so that it can be turned as desired and this kerf also cooperates with a graduated scale V on the outer face of cover A as an index of the position of the movable contact on the resistance winding.

In the case of a two winding transformer T as diagrammatically shown in Fig. 2 transformer T has its primary winding P preferably connected across the plugging in prongs 3 and 4 and prongs 1 and 2 are electrically connected to provide a circuit connector through the device by means of a conductor J. In this instance a casing having only two prongs 3 and 4 could be employed but in addition to a circuit closing element the two additional electrically connected prongs 1 and 2 provide for a more positive and stable mounting for the device. However, in accordance with the diagram in Fig. 3 two primary windings P₁ and P₂ are provided, P₁ being connected between prongs 3 and 4 and P₂ between prongs 1 and 2. Dividing the primary into two sections P₁ and P₂ in this manner is desirable in some instances rather than placing the entire winding P in a single line of the circuit, however, a single winding P on a selected line may be simpler and a preferred arrangement. In both arrangements the transformer secondary winding S is connected with variable rheostat R^V as above described in detail.

Such inductive devices D with variably shunted secondary windings as applied particularly to repeaters of the type indicated in Fig. 4 materially improve the performance thereof. Such a voice repeater is indicated as the interconnection between east and west lines of a long distance telephone circuit. The east and west lines are each connected with terminals of corresponding east and west output transformers OE and OW respectively which in turn are connected with terminals of sockets B for D inductor devices providing connecting elements with the repeater balancing networks N. Details of such a repeater are not shown in this application but may be in general of the character disclosed in my Patent No. 1,996,267 of April 2, 1935 for Voice current amplifier for long distance telephone lines.

In operation in such a system where the inductors D are installed, the installer is provided with test equipment for impedance measurements between 200 and 3000 cycles and the variable ad-

justment on inductors D may be set according to the image-impedance of line at the critical frequencies, and a satisfactory adjustment can be obtained.

However, in setting up either a broad or narrow band tuned circuit to balance out some "lumpy" resonant peak or dip in a line which is not electrically smooth throughout the audio band external condensers are employed in conjunction with the inductors D. Such condensers are diagrammatically shown in Figs. 5 and 6 as X^P and X^S respectively being external condensers of proper values as required to meet local conditions. For example in case of the parallel condensers from 0.1 to 5.0 mf. is found to meet the requirements when employed with inductor D in accordance with the model submitted. Since such condensers are thus employed in conjunction with the inductors D they may be considered as a part of the device and their values of course depend upon the constants of the circuits as will be understood by those familiar with telephone communication practice. Such condensers may be adjusted, as for example, the same as the transformer secondary shunting rheostat R^V.

Figs. 5 and 6 are fragmentary diagrams illustrating inductors D with such condensers as applied in the circuits in Fig. 4. In the disclosures thus far the inductors D are shown connected in series in the lines, however a parallel arrangement, or connection across the line, is frequently desirable and parallel arrangements therefor shown in Figs. 7 and 8 and in these fragmentary diagrams external condensers X^S and X^P are applied to the inductor devices D in the manner referred to in the practice of this invention. While the series or parallel capacity arrangements usually overcome the disturbances referred to it is possible in some instances that additional capacity may be required which may be added as required, Fig. 8 shows such an additional condenser X^L in series in the line.

While the inductor D as just described in detail is particularly applicable in telephone amplifiers and in conjunction with condensers in such circuits it is obvious that such an inductor in accordance with my invention can be used to advantage for other purposes as well, particularly in circuits wherein balancing of conditions for voice frequencies is an important factor.

Having described a preferred embodiment of my invention I do not wish to limit myself to any of the specific constructions or modes of operation described above in this specification for purpose of giving examples or illustrations of employment of the invention, for it will be obvious that wide departure from the above may be made without departing from the spirit and scope of my invention which is as set forth in the following claims.

I claim:

1. An accessory inductance element for insertion in a voice frequency repeater circuit of a telephone system, said inductance element comprising a transformer whose primary is adapted for ready insertion in the circuit between the hybrid coil and balancing network of a repeater system as an auxiliary element therein, said element being adjustable to correct for any unbalance not taken care of by the regular balancing network of the repeater.

2. An inductance element of the character set forth in claim 1 wherein the adjusting means comprises a rheostat connected with the transformer secondary winding.

3. An inductance element of the character set forth in claim 1 wherein the transformer core is of the low loss "dust core" type.

4. An inductance element of the character set forth in claim 1 wherein the transformer is housed in a cylindrical casing, said casing having plugging in prongs on one end to which the transformer primary terminals are connected, and readily accessible adjusting means for the inductance element on the other end of the casing.

5. An accessory inductance element for insertion in a voice frequency repeater circuit of a telephone system, said inductance element comprising a transformer whose primary is adapted for ready insertion in the circuit between the hybrid coil and balancing network of a repeater system as an auxiliary element therein, said element being adjustable to correct for any

unbalance not taken care of by the regular balancing network of the repeater, and a condenser connected with the primary of the transformer for correction of resonant peak or dip disturbances in a line which is not electrically smooth throughout the frequency range of operation.

6. A detachable accessory device for voice repeaters of the hybrid coil and balancing network type in telephone systems, said device including a transformer with primary and secondary windings thereon, attachable terminals on the primary winding for connecting it in a circuit between the hybrid coil and balancing network of the repeater, and a rheostat connected with the terminals of the secondary winding quickly adjustable for balancing circuits of the repeater.

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