J. H. CUNTZ.

TELEPHONE AND TELEGRAPH RELAY OR REPEATER.

APPLICATION FILED FEB. 19, 1903.

1,038,301. Patented Sept. 10, 1912.

Fig. 1.

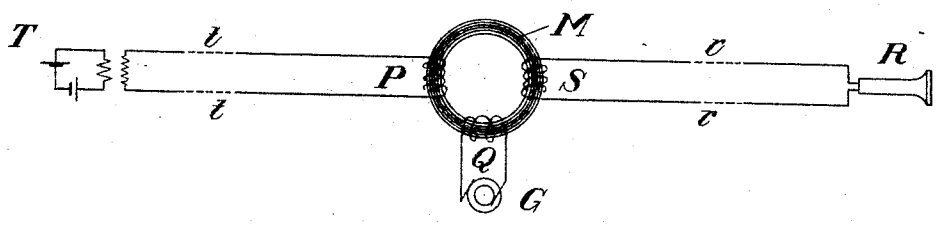


Fig. 2.

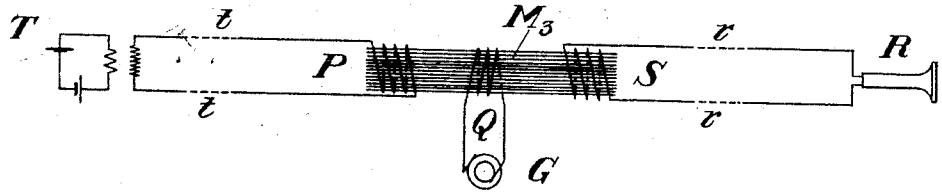


Fig. 3.

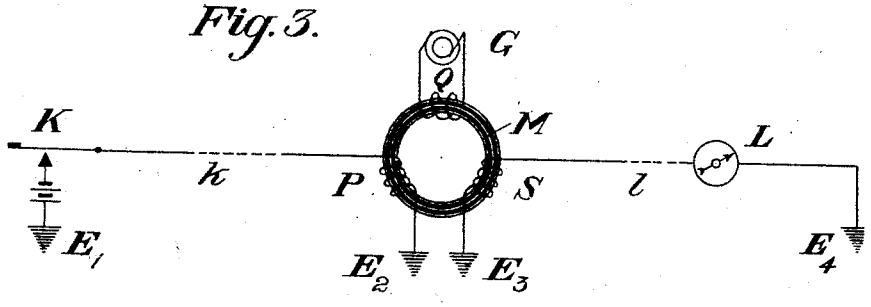
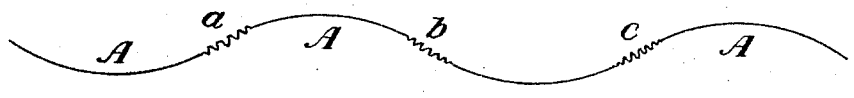


Fig. 4.



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TELEPHONE AND TELEGRAPH RELAY OR REPEATER.

1,038,301. Specification of Letters Patent. Patented Sept. 10, 1912.

Application filed February 19, 1903. Serial No. 144,134.

To all whom it may concern:

Be it known that I, JOHN H. CUNTZ, a citizen of the United States, and resident of Hoboken, in the county of Hudson and State of New Jersey, (whose post-office address is No. 325 Hudson street, Hoboken, New Jersey,) have invented certain new and useful Improvements in Telephone and Telegraph Relays or Repeaters, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to means for relaying or repeating telephone and telegraph messages.

Telephone repeating coils have been used in which there are two windings, a primary and a secondary, variations in the current through one inducing a varying current in the other. But although such coils are of service for certain purposes in telephone work, they have not been found helpful in extending the distance over which telephonic speech may be transmitted.

In my relay, or repeater, in addition to the primary and secondary coils, connected, respectively, to the incoming and outgoing line circuits, I use another coil insulated from the two former and in circuit with an independent source of current. In one form of this relay the coils are wound around an iron core, and a continuous current is passed through the third, or auxiliary, coil, of such a strength that the magnetic field due to it will cause the iron of the core to be at, or about, the point of maximum permeability. It is well known that the permeability of iron varies with the strength of the magnetic field in which it is placed. At low magnetizations, such as are caused by telephonic and submarine-telegraphic currents, the permeability is comparatively low. It (the permeability) increases with increasing magnetization up to a point where the strength of the field is about from 1 to 10 C. G. S. units, varying, of course, with different kinds of iron. After passing this point, the permeability again decreases. The iron when at and near the maximum permeability point is in a state where small variations in the current of the primary coil will cause comparatively great changes to occur in the iron of the core, and, hence, in the induced currents of the secondary coil. The variations of the current in the secondary coil and in the line circuit to which it is connected, will then be equal to those of the primary coil in number, and similar in form, but will have a greater amplitude or intensity, and thus the message will be carried on with increased strength.

When an alternating current is passed through the auxiliary coil, the magnetic particles of the core will be kept in continual motion, and will then be in a particularly sensitive condition, so that any variations in the primary current will cause comparatively great changes in the magnetic state of the core, which changes will induce corresponding variations in the current of the secondary coil, and of the line circuit to which it is connected. For telephone purposes this alternating current should be of a frequency below the limit of audibility, and should have a smooth wave form, without angles or sudden changes and breaks which would cause sounds in the telephones. And whenever the alternating current is used for the purposes here indicated, it should preferably have a very low frequency, just great enough to keep the magnetic particles of the iron in motion, and not so high as to cause any deleterious effects. This slowly alternating current in the auxiliary coil will, of course, induce corresponding currents in the "primary" and "secondary" coils and hence in the line wires but these currents will not produce hurtful effects if the frequency is low enough. There will be on the line an alternating current having a very long period and smooth wave form, on which will be superposed the telephonic and telegraphic currents like little ripples on an ocean ground swell, as indicated in Fig. 4.

For some purposes I prefer to have the alternating current of a mean strength such as will produce a magnetic field which causes the average state of the iron to be at or near that of maximum permeability.

In certain cases it is advantageous for the iron core to form a closed magnetic circuit, and I then make my iron core in the shape of a ring or in some other suitable form. The core is composed preferably of fine wires of iron possessing high permeability and a low hysteresis coefficient.

Besides being of service in telephone work, my relay or repeater is adapted to

telegraph work, and, particularly, to submarine telegraphy, where the currents are very feeble.

My relay or repeater will transmit messages in either direction equally well, and the "primary" coil can act as a "secondary" coil and the "secondary" coil as a "primary," with equal facility. The names "primary" and "secondary" are used in these specifications for the sake of clearness.

In the accompanying drawings, Figure 1 represents a relay or repeater with a ring-shaped iron core, about which are wound a primary coil, connected to the incoming line wires, a secondary coil, connected to the outgoing line wires, and an auxiliary coil connected to an independent source of alternating current. Fig. 2 represents a relay or repeater with a straight iron core, the primary, secondary and auxiliary coils being connected as in Fig. 1, the auxiliary coil, as shown, being in circuit with an independent source of alternating current. Fig. 3 represents a relay or repeater in a telegraphic system such as may be used in submarine work. Fig. 4 is a curve representing an alternating-current wave of very long period, or low frequency, with shorter current waves, of higher frequency, such as occur in telephone and telegraph work superposed upon it.

In Fig. 1, M is an iron or steel ring composed, preferably, of thin, iron wires, on which are wound: a primary coil, P, in circuit with the line wires, *t*, *t*, and the telephone transmitter, T; a secondary coil, S, in circuit with the line wires, *r*, *r*, and the telephone receiver, R; and the auxiliary coil, Q, in circuit with the source of alternating current, G.

In Fig. 2, M_2 is an iron or steel straight core composed, preferably of thin iron wires, on which are wound: a primary coil, P, in circuit with the line wires, *t*, *t*, and the telephone transmitter, T; a secondary coil, S, in circuit with the line wires, *r*, *r*, and the telephone receiver, R; and the auxiliary coil, Q, in circuit with the source of alternating current, G.

In Fig. 3, M is a core of iron or steel, but preferably composed of thin iron wires, on which are wound: a primary coil, P, in circuit with the line wire, *k*, and the telegraphic transmitting apparatus, K, the circuit being completed through the earth connections E_1 and E_2; a secondary coil, S, in circuit with the line wire, 1, and the telegraphic receiving apparatus, L, the circuit being completed through the earth connections E_3 and E_4; and an auxiliary coil, Q, in circuit with a source of alternating current G.

In Fig. 4, A, A, A, is a curve representing an alternating-current wave of very long period on which are superposed high-frequency telephonic or telegraphic currents, shown at *a*, *b* and *c*.

All of the coils, P, S, and Q, mentioned in these specifications, are insulated from the iron core, from each other and between their own turns.

In all the figures, the "primary" coil, P, will act as a secondary coil, and the "secondary" coil, S, will act as a primary coil when the direction of transmission is reversed, and will act thus equally well as before; they have been shown in the figures as designated for the sake of clearness. Also, for the sake of clearness, the coils have been shown, in all the figures, as occupying separate portions of the core, but they may equally well be wound over each other in layers, properly insulated from each other, and may be in two or more sections, properly connected.

For transmitting in both directions, the number of turns of the "primary" and "secondary" coils are preferably equal. When continuous current is used in the auxiliary coil, the strength of the current and the number of turns of the coil should be so proportioned, that a magnetic field will be created of an intensity such that the iron of the core will be at or about its state of maximum permeability.

The frequency of the auxiliary alternating current should preferably be very low, and for telephonic purposes should be below the limits of audibility.

In general, the figures are diagrammatic, and show the objects described in conventional form, and I do not confine myself to the exact constructions here indicated, but

What I here claim as my invention and desire to secure by Letters Patent is:

1. In combination, in a relay or repeater, a plurality of coils in inductive relation to each other, and an auxiliary coil through which is flowing a periodically varying current of approximately constant mean strength.

2. In combination in a relay or repeater, a plurality of coils in inductive relation to each other, and an auxiliary coil through which is flowing a uniformly varying current from an independent source.

3. In combination in a relay or repeater, a plurality of coils in inductive relation to each other, and an auxiliary coil through which is flowing, from an independent source, an alternating current of a frequency below the limits of audibility.

4. A relay or repeater, including an auxiliary coil through which flows a regularly varying current from an independent source, and coils in circuit with line wires, and in inductive relation to the auxiliary coil.

5. In combination, in a relay or repeater, an iron core, a plurality of coils in inductive relation to each other and to the iron core,

and an auxiliary coil through which flows a periodically varying current during the entire time of operation.

6. In combination in a relay or repeater, an iron core, a plurality of coils in inductive relation to each other, and an auxiliary coil through which is flowing an alternating current of a frequency below the limits of audibility from an independent source.

7. A relay or repeater including an iron core, an auxiliary coil through which is flowing a regularly varying current from an independent source, and coils in inductive relation to the auxiliary coil and the iron core.

This specification signed and witnessed this 18th day of February, A. D. 1903.

JOHN H. CUNTZ.

In the presence of—
ANTHONY N. JESBERA,
LUCIUS E. VARNEY.