Jan. 16, 1923.

1,442,130.

H. D. CURRIER.

TELEPHONE SYSTEM.

FILED JULY 18, 1918.

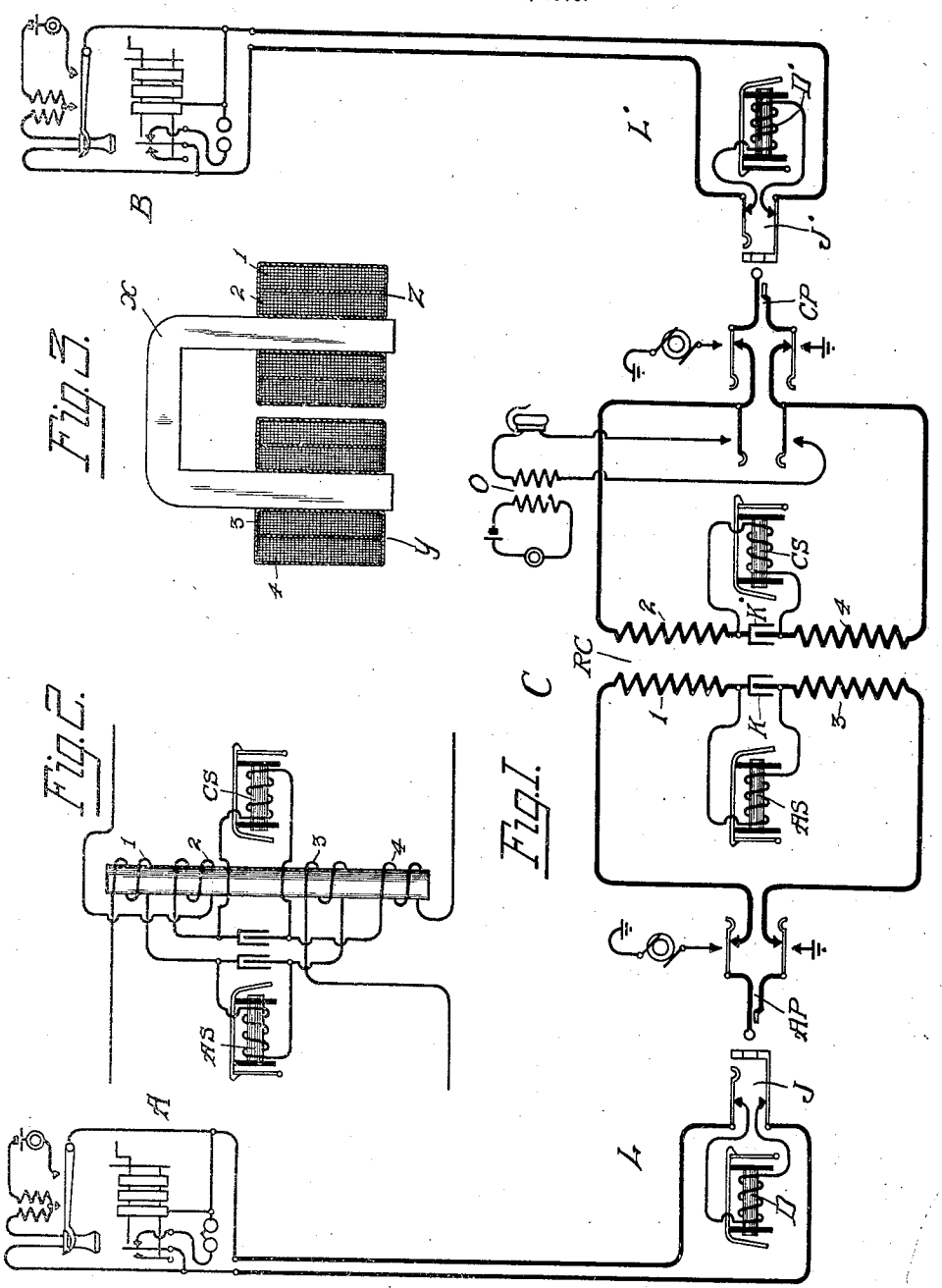

Fig. 1.

Fig. 3.

Fig. 2.

Inventor:
Hiram D. Currier.
By Curtis B. Camp.
Attorney

Patented Jan. 16, 1923. 1,442,130

UNITED STATES PATENT OFFICE.

HIRAM D. CURRIER, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

Application filed July 18, 1918. Serial No. 245,446.

To all whom it may concern:

Be it known that I, HIRAM D. CURRIER, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to repeating coils or telephone transformers, and has to do more particularly with repeating coils of the non-ring through type such as are used in cord circuits or link circuits for connecting together the subscribers' telephone lines of a telephone exchange system.

My present invention is designed to prevent alternating currents of a low frequency from passing through repeating coils from one side of the circuit to the other, but offers no resistance whatever to the passing through of alternating currents of a higher frequency, such as talking currents.

In magneto telephone systems, it is desirable to have double supervision, that is, to have one supervisory device controlled by the calling subscriber and one controlled by the called subscriber. A great deal of trouble has been encountered in providing double supervision of the character above described owing to the fact that the generator current sent in by either subscriber over his telephone line when signaling the operator, particularly when the subscriber's line is a short one, not only operates the subscriber's own supervisory signal but also passes through the repeating coil in the cord circuit and operates the other subscriber's supervisory signal. Some attempts have been made to overcome this undesirable feature but they have always ended with the result that the efficiency of the repeating coil for talking purposes has been greatly impaired to a practically uncommercial point, or the repeating coil would permit a small amount of ringing current to pass through so that when the supervisory device is adjusted to work on a weak current over a long line it will also work over a short line by current transmitted through the repeating coil from the other end of the cord circuit.

I have arranged the windings of the repeating coil of my invention so that when currents of low frequencies are transmitted a differential effect is obtained upon the core of the repeating coil, but when currents of higher frequencies are transmitted, owing to the enormous impedance offered by these windings to the talking current, the repeating coil functions as two separate transformers connected in series, although they are located upon the same core.

The above-mentioned features, as well as others, will be more particularly pointed out in the ensuing specification and in the appended claims.

Referring to my invention as illustrated in the accompanying drawing in which like characters denote like parts,

Fig. 1 shows a complete circuit connection between a calling and a called subscriber through the medium of a link circuit provided with a repeating coil of my invention.

Fig. 2 shows how the windings of my repeating coil are connected; and

Fig. 3 shows the relative position of the windings of my repeating coil.

Referring to Fig. 1, this circuit represents diagrammatically a magneto substation A which terminates at the central exchange in line equipment L; a called substation B which terminates in line equipment L′; and a cord circuit C for connecting line A to line B.

The magneto substation A comprises the usual talking equipment and hand generator or magneto, and terminates in the central office in the usual drop D and jack J.

The cord circuit C comprises the usual answering plug AP and calling plug CP inductively connected together by means of the talking strands of the cord circuit. An answering supervisory device AS and a calling supervisory device CS are furnished. A repeating coil RC is provided and has four windings connected intermediate the ends of the cord circuit, windings 1 and 3 of the cord circuit being connected together through a condenser K, and windings 2 and 4 of the cord circuit being connected together through the condenser K′.

An operator's telephone set O and the usual ringing and listening keys are also provided. The equipment of the substation B and the line circuit L′ are the same as the equipment of the substation A and line circuit L.

Referring to Fig. 2, this drawing shows the core of the repeating coil extended as if it were a straight piece and shows the

manner in which the windings of the repeating coil are connected. Winding 1 of the repeating coil extends around the core in one direction while winding 3, with which winding 1 connects, is wound around the core in the opposite direction, thereby causing the lines of force set up in the core of the repeating coil in one direction by one winding to be neutralized by the lines of force set up in the core of the coil by the other winding in the other direction when an impulse of current of a low frequency is passed through these windings. Winding 4 of the repeating coil, which is connected in series with winding 2 of the repeating coil, is also wound around the core in the opposite direction to that of winding 2, so that one of these windings tends to neutralize the magnetic effect of the other of these windings when an impulse of low frequency current is passed through these windings.

Referring now to Fig. 3, the repeating coil or inductorium comprises a U-shaped core X preferably made of small gauge Norway iron which is wrapped with tape to help keep its cylindrical form. The core is made of small gauge Norway iron to reduce the hysteresis loss to a minimum. The coil is made up of two spools Y and Z, each spool having two windings, namely, an outside winding 1 and an inside winding 2 on spool Z, and an outside winding 4 and an inside winding 3 on spool Y.

The windings are connected so that the inside winding of one spool is connected to the outside winding of the opposite spool, and these two windings form one-half of the transformer circuit. This arrangement permits each half of the transformer circuit being in the same dimensional relation to the core. With this arrangement, which results in each half of the transformer circuit being in the same dimensional relation to the core, the current induced from one-half of the transformer to the other reacts on the core to the same degree as the impressed current with the result that transformation is obtained with the minimum loss.

Owing to the fact that the core of the coil is comparatively short, the lines of magnetism, built up by energizing one winding of a pair of windings, have time to neutralize the lines of force built up by the other winding of the pair of windings when the frequency of the current is low, but when the frequency of the current is very rapid, as is the frequency of talking current, the winding at each end of the core acts as a separate transformer, the effect being like two transformers having their primaries and secondaries connected in series. If the core of the coil should be extended to a great enough length, then the winding on each end of the core would function as a separate transformer for the lower frequencies.

Having described in general the apparatus embodying my invention, I will now briefly describe the operation of such apparatus.

When a call is sent in from the calling substation A, the subscriber's line drop D is operated in the usual manner and the operator answers by connecting the answering plug AP of the cord circuit C to the jack J of the calling line and inquires the wants of the calling subscriber. The operator next tests the line of the called for subscriber and completes the connection thereto, if the line is idle, by connecting the calling plug CP to the jack J′ of the called line.

The subscribers now converse over the heavily marked conductors, and the repeating coil RC operates very efficiently to repeat the high frequency talking current from one end of the cord circuit to the other.

When the subscribers are through talking, they both operate their hand generators to operate their respective supervisory signals. The calling subscriber operating his hand generator operates the supervisory device AS, and the called subscriber operating his hand generator operates his supervisory device CS. The low frequency generator current sent into the exchange from either the answering end of the cord circuit or from the calling end of the cord circuit does not pass through the repeating coil RC and operate the supervisory device at the other end of the cord circuit, due to the differential action of the coils upon the core of the coil RC when current of low frequency is sent through either pair of windings of the transformer.

While the invention has been described with particular reference to the details of construction, it should be understood that it is not limited thereto, as many changes and modifications may be made therein without departing therefrom, and I therefore wish to cover all such changes and modifications which come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. In a transformer, a U-shaped core composed of magnetic material having windings on the arms of said core, said windings comprising two primary and two secondary windings, one primary and one secondary winding being mounted on one arm portion of the core and the other primary and secondary windings being mounted upon the other arm portion of the core, the primary winding mounted on one arm portion of the core being an inside winding and connected to the primary winding mounted on the

other arm portion of the core which is an outside winding, the two primary windings being wound in opposite directions, a supervisory signal connected in bridge circuit between said primary windings, a condenser interposed between said primary windings for causing current to pass through said supervisory signal to operate the same, the secondary winding on one arm portion of the core which is an outside winding being connected to the secondary winding on the other arm portion of the core which is an inside winding, the two secondary windings being also wound in opposite directions substantially for the reasons set forth, another supervisory signal connected in bridge circuit between said secondary windings, and a condenser interposed between said secondary windings for causing current to pass through said second supervisory signal to operate the same.

2. In a transformer, a U-shaped core composed of magnetic material having windings on the arms of said core, said windings comprising two primary and two secondary windings, one primary and one secondary winding being mounted on one arm portion of the core and the other primary and secondary windings being mounted upon the other arm portion of the core, the primary winding mounted on one arm portion of the core being an inside winding and connected to the primary winding mounted on the other arm portion of the core which is an outside winding, the two primary windings being wound in opposite directions so as to have a neutralizing effect upon the core of the transformer for a low frequency current but each set of windings functioning as a separate transformer for high frequency current, a supervisory signal connected in bridge circuit between said primary windings, a condenser for causing low frequency current to pass through said supervisory signal to operate the same, the secondary winding on one arm portion of the core which is an outside winding being connected to the secondary winding on the other arm portion which is an inside winding, the two secondary windings being also wound in opposite directions substantially for the reasons set forth, another supervisory signal connected in branch circuit between said secondary windings, and a condenser interposed for causing current of a low frequency to pass through said last supervisory signal to operate the same.

3. A transformer of the character described having a U-shaped core provided with two sets of two windings each, the inside winding of the one set being connected to the outside winding of the other set to form one-half of the transformer circuit, one of said windings being wound in a dextrorsal manner and the other of said windings being wound in a sinistrorsal manner, the other two windings of the said two sets being respectively inside and outside windings and connected to form the other half of the transformer circuit, said two latter windings likewise being connected in a dextrorsal and sinistrorsal manner, each connected pair of windings being wound so as to have a neutralizing effect upon the core of the transformer for a low frequency current but each set of windings functioning as a separate transformer for higher frequency current, a pair of supervisory signals one of which is in circuit between one of said pairs of windings and the other signal connected in circuit between the other one of said pairs of windings, a condenser in series circuit with and between one of said pairs of windings, and a condenser in series circuit with and between said other pair of windings, said condensers permitting low frequency current to pass through said supervisory signals to cause the operation of the same, said supervisory signal being non-responsive to high frequency current.

Signed by me at Chicago, in the county of Cook and State of Illinois this 15th day of July, 1918.

HIRAM D. CURRIER.