

K. S. JOHNSON.
ELECTROMAGNETIC COIL.
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1,297,858.

Fig. 1.

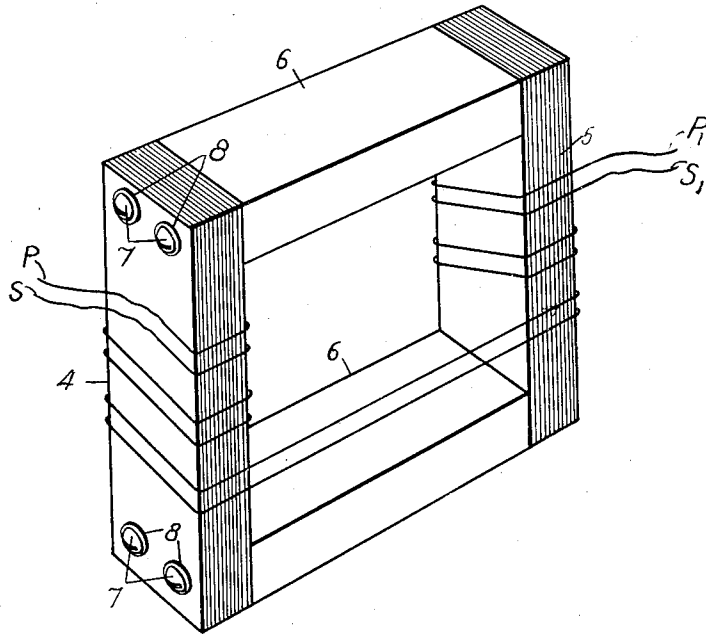
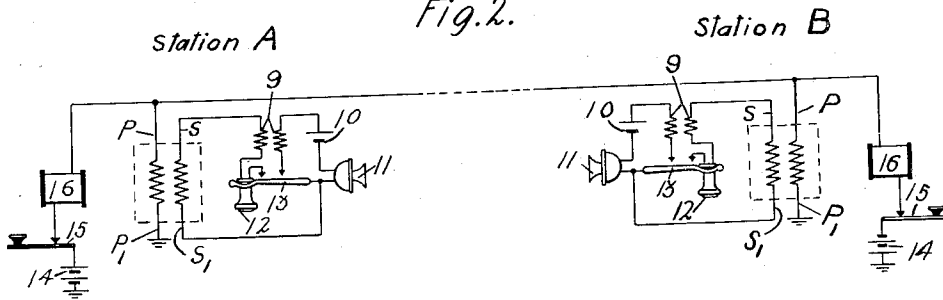


Fig. 2.



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC COIL.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, KENNETH S. JOHNSON, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Electromagnetic Coils, of which the following is a full, clear, concise, and exact description.

This invention relates to electrical transformers and in particular to a type which is efficient with currents of high frequency but is inefficient with currents of low frequency.

In the field of electrical transmission of messages there is considerable need for a means which will permit the transmission of alternating currents of certain frequencies but suppress, either entirely or partially, the transmission of currents of other frequencies. Such is the case particularly in connection with wireless telephony and telegraphy and with composite telephone lines which are adapted for the simultaneous sending of telephone and telegraph messages. In such systems it is desirable to transmit currents of a frequency of from approximately 400 to 2,000 cycles but to suppress currents of a lower frequency, as for example, the 16 cycle ringing current ordinarily used and the low frequency Morse currents. In various other circuits, it is also highly advantageous to provide means for preventing the transmission of all currents except those within a given frequency range.

Heretofore it has largely been the practice to suppress or filter out the currents of undesired frequency by means of resonant shunts or by certain combinations of inductances and capacities. This method although effective requires the use of considerable apparatus especially when it is desired to suppress currents of comparatively low frequency, such for example as those required in signaling on telephone lines and the sending of Morse signals. Under such conditions the capacities required are such as to practically preclude their use in portable sets and in other cases the cost is prohibitive for commercial reasons.

It is therefore the object of the present invention to provide a means for suppressing currents of low frequency and at the same time permit the transmission of currents of high frequency, such apparatus be-

ing compact, low in weight and cheap to manufacture.

In accordance with a feature of this invention there is provided an electromagnetic coil, the magnetic circuit of which comprises a plurality of sections, of a material having high permeability and low hysteresis and eddy current losses, these sections being joined by yoke pieces of a material having high hysteresis and eddy current losses. Upon each of the former sections are wound a primary and secondary winding, the corresponding windings in each case being joined together in series opposed to each other.

The invention is illustrated in the accompanying drawing, in which Figure 1 illustrates a structure embodying this invention; and Fig. 2 illustrates a simplified circuit in which a structure of this type may be employed.

The magnetic circuit of this coil comprises core sections 4 and 5, composed of laminations of a material having high permeability and low hysteresis and eddy current losses, silicon steel having been found particularly suitable for this purpose. The core sections 4 and 5 are joined by the solid yoke pieces 6—6, of a material having high hysteresis and eddy current losses, such for example as wrought iron, cast iron or hardened steel. These yoke pieces are held in place by means of the screws 7—7 and the washers 8—8. The windings comprise a primary winding P—P¹ and a secondary winding S—S¹, each of which is equally and symmetrically wound on the core sections 4 and 5, the portions of each winding being so connected that the fluxes generated by a flow of current therein, are in a direction to oppose and neutralize each other. In response to the flow of alternating currents of low frequency the series opposing connection of P—P¹ as well as that of S—S¹ will make the transformer of practically zero efficiency, while in response to currents of high frequency the effective permeability of the yoke pieces 6—6 will be but slightly higher than that of air, hence the device at this frequency will act as two separate transformers connected in series. The loss of effective permeability with increasing frequency is due chiefly to the effect of the eddy currents in the yoke pieces and to a lesser degree to hysteresis losses in the yoke pieces,

The loss due to eddy currents increases approximately in proportion to the square of the frequency and hence over the telephonic range of frequencies (approximately 400 to 2,000 cycles) is excessively large and the structure acts as would two separate transformers connected in series, each developing its own independent field. At the lower frequencies (16 to 100 cycles) the eddy current losses in the yoke pieces will be relatively very small and hence the transformer will be very inefficient, acting as would any ordinary closed core transformer in which the two primary windings and the two secondary windings are each connected in series opposing to each other. The loss, due to hysteresis currents, increases somewhat faster than in direct proportion to the frequency and hence aids in further decreasing the effective permeability of the yoke pieces.

Referring now more particularly to Fig. 2 there is shown a composite line suitable for the simultaneous sending of telephone and telegraph messages, the customary condensers and impedance coils being eliminated and the transformer or repeating coil embodying this invention being provided at each telephone station to prevent any disturbance from the telegraph circuit reaching the telephone sets. While only two sets are shown connected to the line it will be obvious that other sets may be provided as desired. As illustrated, the telephone apparatus at each station consists of a transformer or repeating coil of the type shown in Fig. 1 and having its primary winding $P-P^1$ connected between the line and ground. The terminals of the secondary winding $S-S^1$ are connected directly to an ordinary local battery telephone set consisting in this case of the induction coil 9, battery 10, transmitter 11, receiver 12 and hook-switch 13. The telegraph apparatus at each station comprises a grounded source of energy 14, telegraph key 15, and relay 16, connected to the line wire as shown. It will be understood that at each station and associated with the relay 16 there will be a local circuit comprising a telegraph sounder and battery not shown in the drawing. The signaling current of low frequency traversing the line wire as a result of the opening and closing of the key 15 will flow through the primary windings $P-P^1$ at each telephone station, but due to the construction of the transformer as already described similar currents will not be induced into the secondary winding $S-S^1$, hence no disturbance will be created at this

station due to the operation of the telegraph apparatus. On the other hand in response to alternating currents of telephonic frequencies traversing the line wire the transformer functions efficiently, the high frequency currents being induced into the secondary winding $S-S^1$.

What is claimed is:

1. An electromagnetic coil comprising a plurality of cores, yoke pieces composed of a material having high hysteresis and eddy current losses mechanically separating and magnetically connecting said cores, and a plurality of windings on each core, like windings on the different cores being connected together in series opposing.

2. An electromagnetic coil comprising a plurality of cores composed of a material having high permeability and low hysteresis and eddy current losses, yoke pieces mechanically separating and magnetically joining said cores, said yoke pieces being composed of a material having high hysteresis and eddy current losses, and a plurality of windings on each of said cores, corresponding windings on the different cores being connected together in series opposing.

3. An electromagnetic coil comprising a plurality of laminated cores mechanically separated from each other and magnetically connected by solid yoke pieces, and a primary and a secondary winding on each core, said primary windings being connected together in series opposing and said secondary windings being connected together in series opposing.

4. In a device for selectively transmitting electrical waves, a plurality of coils adapted to be included in a transmission line, a magnetic core for each of said coils, and a magnetic connection between said cores, said connection offering high reluctance to rapid changes of flux in said cores and low reluctance to slow changes of flux in said cores.

5. In a device for selectively transmitting electrical waves, a plurality of coils, a magnetic core for each of said coils, and a magnetic connection between said cores, said connection being composed of a material having high hysteresis and eddy current losses adapted to permit the interchange between said cores of slowly changing flux and to prevent the interchange of rapidly changing flux.

In witness whereof, I hereunto subscribe my name this 5th day of December, A. D. 1917.

KENNETH S. JOHNSON.