No. 817,926. PATENTED APR. 17, 1906.

C. A. LOHR.

TRANSFORMER.

APPLICATION FILED APR 27, 1905.

Fig. 1.

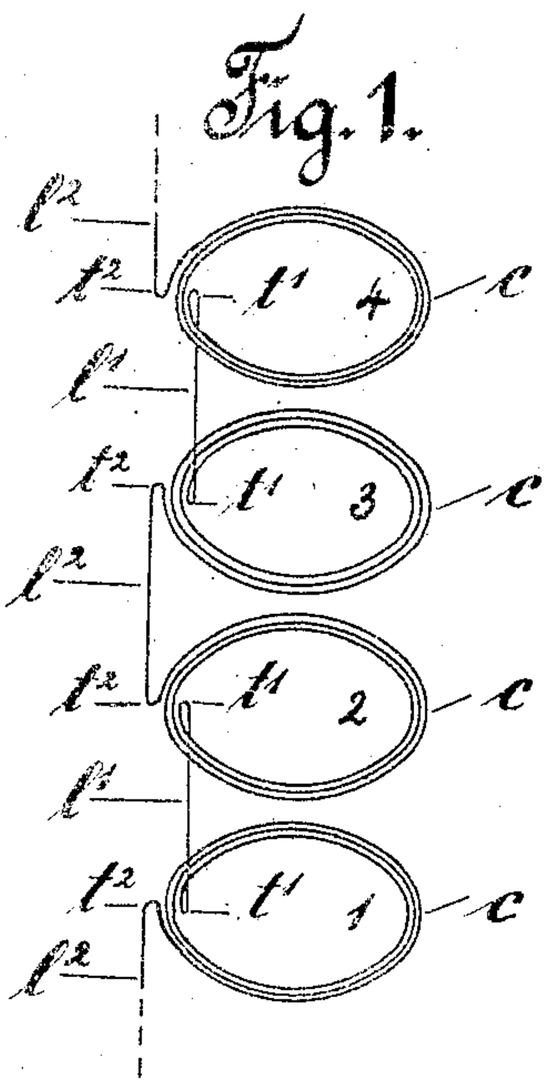


Fig. 2.

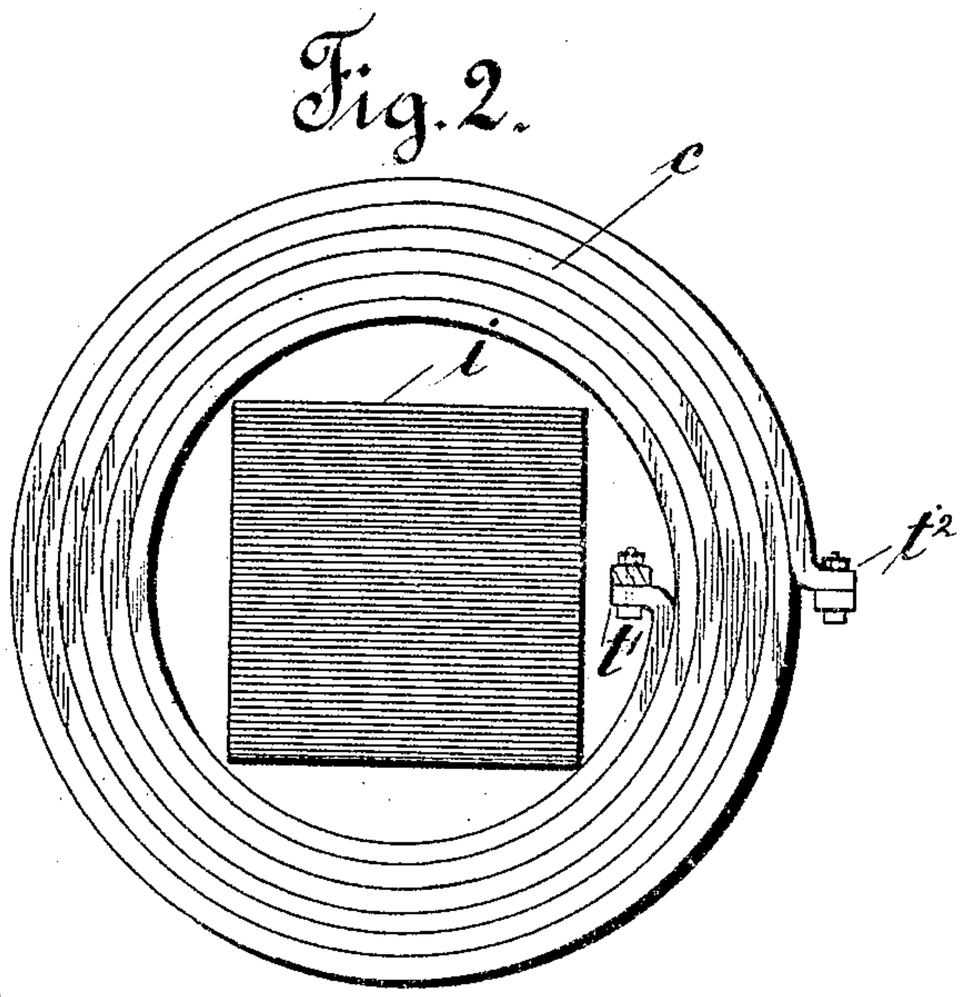


Fig. 3.

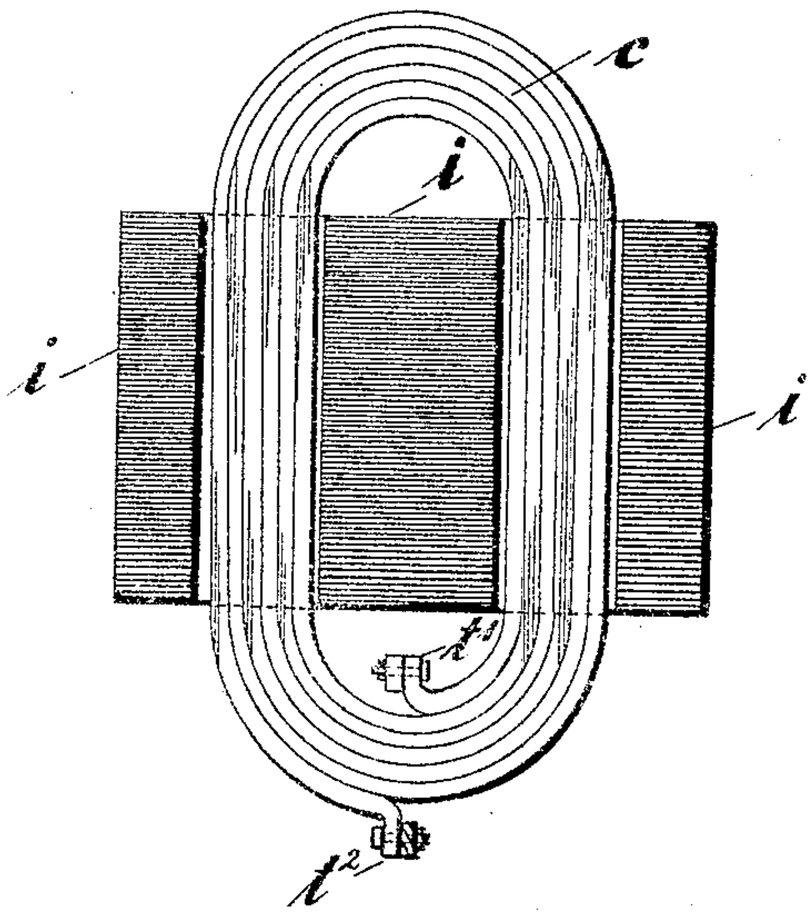
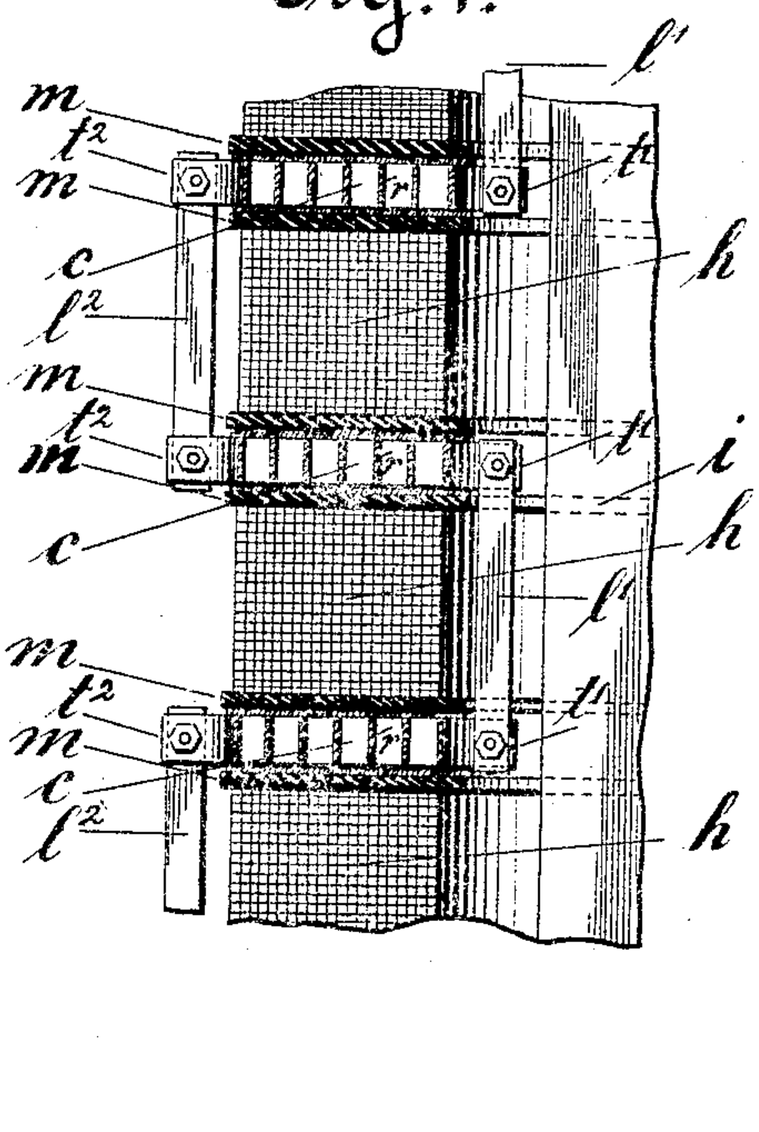


Fig. 4.



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TRANSFORMER.

No. 817,926. Specification of Letters Patent. Patented April 17, 1906.

Application filed April 27, 1905. Serial No. 257,644.

To all whom it may concern:

Be it known that I, CARL A. LOHR, a subject of the German Emperor, and a resident of Wilkinsburg, Pennsylvania, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

In the construction of transformers it is not only desirable but necessary in order to diminish the magnetic leakage and the consequent so-called "inductive" loss of voltage to place the windings of the circuits as near together as possible. The windings of the circuits may be brought into intimate relation by inclosing those of the low-voltage circuit within those of the high-voltage circuit, and while theoretically that would be the best mode of construction it is impracticable by reason of the difficulty of securing proper insulation. In order to approach in practice the best theoretical conditions, the two windings should be divided and arranged so that the sections of one circuit will alternate with those of the other without any intervening space except that for necessary insulation. Additionally, each section of the low-voltage circuit should comprise not more than one coil of a single layer, since the low-voltage circuit always has less windings than the high-voltage circuit.

One objection incident to constructions in which the low-voltage sections comprise coils in two or more layers is that a considerable separation is effected between the low-voltage and the high-voltage windings, giving less efficient results than that following from the use of a single layer, the use of wire of one-half cross-sectional area in the adoption of two layers rendering it impossible to secure the necessary number of ampere-turns, as will be obvious from a simple calculation after Ohm's law. Additionally, with two layers in each low-voltage section the terminals are on the outside, and the connections between such sections must therefore be made on the outside.

The present invention has for its object a practical subdivision of the circuits as high as possible and their arrangement in alternating sections. Each low-voltage section comprises a coil of a single layer and the connection of the terminals of the different low-voltage sections effected by wires or links arranged alternately on the inside and outside of the high-voltage sections in order to avoid cross connections between the inner terminals of the low-voltage sections which would necessarily result in a more or less undesirable separation between the high and low voltage sections.

The invention will be understood by reference to the accompanying drawings, in which—

Figure 1 is a diagrammatic view illustrating the manner of connecting the terminals of the sections of the low-voltage circuit. Fig. 2 is a view, partly in section and partly an end elevation, of one type of the transformer. Fig. 3 is a similar view of another type of transformer, and Fig. 4 is a longitudinal sectional view of part of an assembled transformer which may be built after either of the above types.

Similar reference characters indicate similar parts in the several views.

Referring to the drawings, the letter *i* designates the iron core of the transformer, which, as usual, is made of laminated iron, and it may be either of the form shown in Fig. 2, known as the "core" type, or that of Fig. 3, known as the "shell" type. The high and low voltage circuit-windings are in section adapted to the particular type of core, that of Fig. 2 being circular and that of Fig. 3 being elliptical. Fig. 4 shows a portion only of the iron core, the construction and arrangement of the windings being as follows: The sections of the high-voltage circuit are designated by the letter *h*, and between them are placed the sections of the low-voltage windings designated by the letter *c*. The respective windings are divided into as many sections as possible and placed flat one against the other, so as to alternate, as shown in Fig. 4. Each low-voltage section comprises a coil of wire, preferably square or rectangular in section formed in a single layer and wrapped with suitable insulation *r*, and between contiguous high and low voltage sections is inserted a sheet of insulating material *m*. It is to be noted that by so arranging the sections of the two windings there is no intervening space between contiguous sections and that it is possible to divide the windings into a large number of sections separated only by the insulation.

t and *t'*, respectively, designate the inner and outer terminals of the several sections of the low-voltage circuit, and by reason of the employment of a single layer for each section of said circuit the inner terminals necessarily come at one end of the inner convolutions

and between the coil and the iron core. In the space thus afforded between the windings and the iron core I connect the inner terminals t' of the two sections of the low-voltage circuit by links or wires l' in such manner that the inner terminal of section 1 will be connected with the inner terminal of section 2, 3 with 4, 5 with 6, &c. The outer terminals t^2 are connected by similar links or wires in such manner that the outer terminal of section 2 will be connected with the outer terminal of section 3, the outer terminal of section 4 with the outer terminal of section 5, 6 with 7, and so on, the links or connecting-wires l' and l^2 alternating in their arrangement under and over the adjacent coils of the sections of the high-voltage circuit, as shown in Fig. 4. It will thus be seen that I am enabled to construct the sections of the low-voltage circuit of a coil of a single layer and to connect the inner terminals of said sections in a simple manner, thereby avoiding cross connection between the high and low voltage sections of the windings, which would interfere with the proper disposition of the sections of the two windings. The space between the iron core and the sections of the windings is always sufficient to secure the placing of the inner connecting-links l' a proper distance from the high-voltage coils, particularly if, as usual, in high-voltage transformers the whole tronsformer is surrounded with oil. The inner connecting-links l' are usually not over one inch in length, and their effect upon the magnetic field is so small as to be negligible. By making the links l' of a zigzag conformation their inductive action will be reduced to *nil*. Straight connecting-links, however, can be used without any obnoxious effects.

In building up the transformer care must be observed that in every section of the low-voltage winding the current shall flow in the same direction. By simply turning one of the two connected coils this result may be secured without the necessity of winding the coils in opposite directions. The flow of the current in the low-voltage section and the manner of connecting the coils will be understood by reference to Fig. 1 to be from the outer terminal of the first low-voltage section through the winding to the terminal t' of that section, inner connecting-link l' to the inner terminal t' of the second section, through the winding of the second section to the outer terminal t^2 thereof, through the outer connecting-link l^2 between the second and third sections, through the winding of the third section to the inner terminal thereof, through the inner connecting-link between the third and fourth sections to the inner terminal t' of the latter, through the fourth section of the outer terminal t^2 thereof, and so on throughout all the sections of the low-voltage circuit.

What I claim, and desire to secure by Letters Patent, is—

1. A transformer comprising high and low voltage circuits the said circuits being divided into alternately-disposed sections, links connecting the inner and outer terminals of the sections of the low-voltage circuit, said links being disposed alternately inside and outside of the sections of the high-voltage circuit.

2. A transformer comprising high and low voltage circuits each circuit comprising a plurality of alternately-disposed sections, each section of the low-voltage circuit having inner and outer terminals, connections between the inner and outer terminals, said connections being alternately disposed between the successive sections.

3. In a transformer the combination of a high-voltage circuit, a low-voltage circuit, both circuits being divided into sections placed alternately one against the other, connections between the inner terminals of the sections of the low-voltage circuit, connections between the outer terminals of said sections, said inner and outer connections being alternately disposed.

4. In a transformer the combination of a high-voltage circuit, a low-voltage circuit, both circuits being divided into alternately-disposed sections each section of the low-voltage circuit consisting of a coil in a single layer, links connecting the inner and outer terminals of the sections of the low-voltage circuit, said links being disposed alternately on the inside and outside of the sections of the high-voltage circuit.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CARL A. LOHR

Witnesses:
OLIN A. FOSTER,
HARRY SCHRAGE.