J. J. FRANK.

TRANSFORMER.

APPLICATION FILED DEC. 17, 1907.

919,338.

Patented Apr. 27, 1909.

Fig. 1

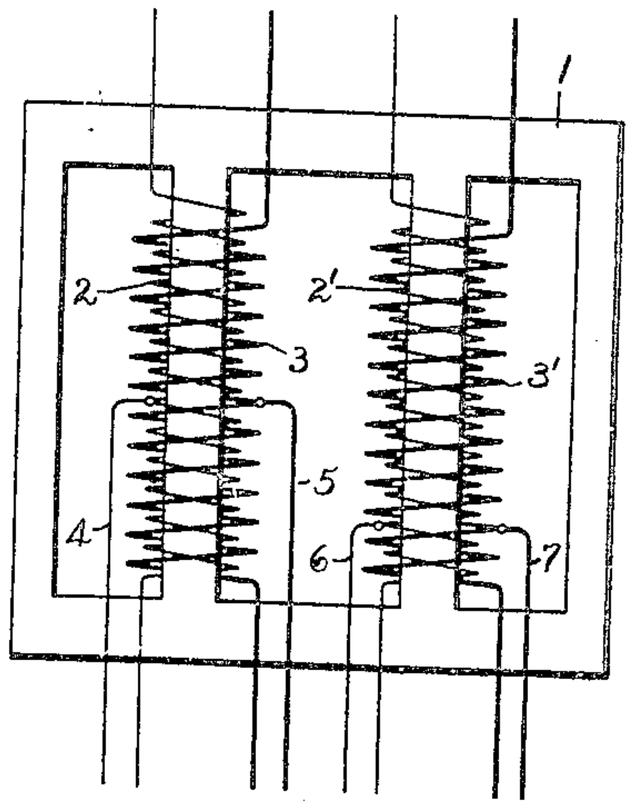


Fig. 2

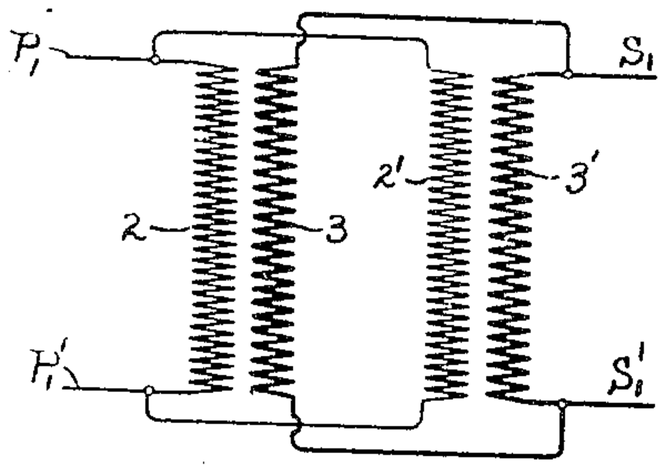
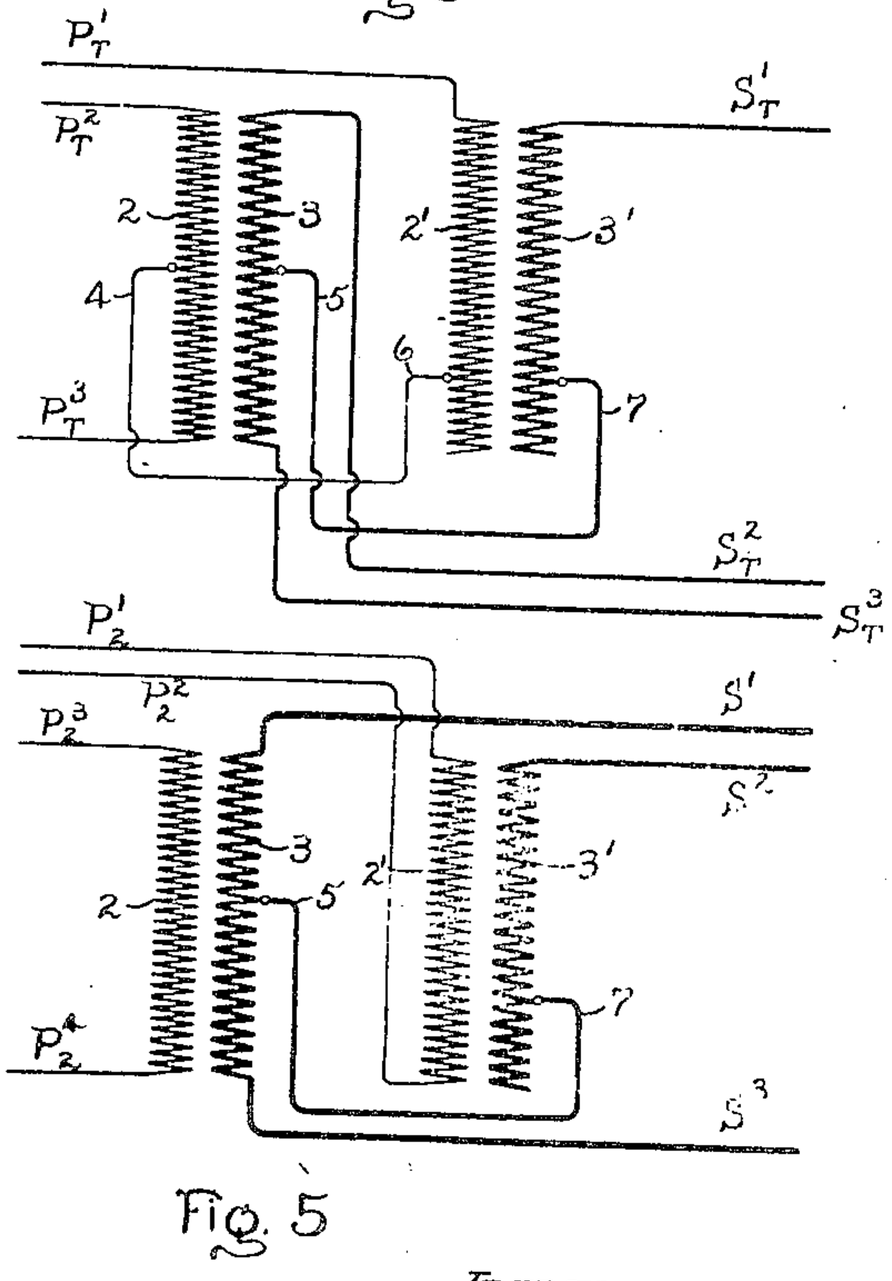


Fig. 3



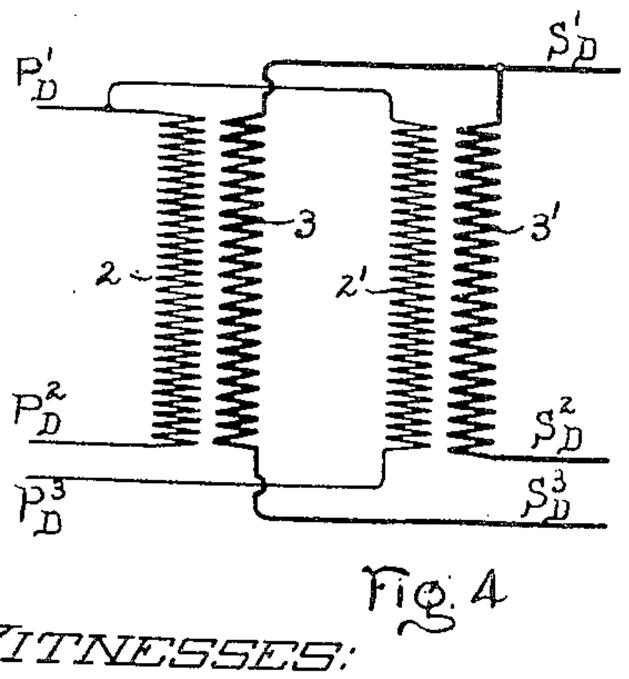


Fig. 4

Fig. 5

WITNESSES:

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UNITED STATES PATENT OFFICE.

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TRANSFORMER.

No. 919,338. Specification of Letters Patent. Patented April 27, 1909.

Application filed December 17, 1907. Serial No. 406,880.

To all whom it may concern:

Be it known that I, JOHN J. FRANK, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Transformers, of which the following is a specification.

My invention relates especially to alternating-current transformers of the core type, and more especially to transformers which are used for the transformation of the energy of polyphase electric circuits.

In the past it has been the custom to use for transforming polyphase circuits either a number of individual single-phase transformers suitably interconnected, or a single polyphase unit such, for example, as the three-phase transformer. If, however, it is desired to transform the energy of electric circuits of a different number of phases, if individual single-phase transformers are used, it either becomes necessary to cut one of these out, or to add thereto; or if a polyphase transformer is used upon a circuit of a different number of phases than that for which it was originally designed, the transformer can either not be operated, or, for example, in the case of a three-phase transformer operating upon a two-phase circuit, it will be operated with a great lack of efficiency, as a considerable amount of the winding will be idle.

My invention seeks to construct a transformer which may be operated cheaply and efficiently upon electric circuits of different numbers of phases by a suitable construction of the core and its windings, and such suitable interconnections of the windings that the transformer may be operated with substantially the same degree of efficiency whether it be operated upon any of the different phase-combinations for which it is designed.

For a further understanding of my invention, reference may be had to the drawings which accompany, and are made a part of this specification.

Figure 1 shows diagrammatically one form of transformer in which my invention may be carried out; Figs. 2 to 5 show certain of the combinations of the windings which may be made for operating my transformer upon electric circuits of different numbers of phases.

Referring first to Fig. 1, 1 shows a laminated magnetic core which may be made in any of the fashions well understood in the art. This core is shown as constructed with four legs, and around the two center legs are wound primary coils 2 2′, and secondary coils 3 3′. Connected intermediately between the ends of these windings are shown certain taps 4—5, 6—7, which are used in order to suitably connect the transformer for operation upon three-phase circuits.

In Fig. 2, I have shown the connections for operating the transformer upon a single-phase circuit. P_1 P^1_1 show the conductors of the primary circuit, and S_1 S^1_1 show the conductors of the secondary circuit. Windings 2 2′ and 3 3′ are shown as connected respectively in parallel.

Fig. 3 shows a connection of my transformer for operation on a three-phase circuit, the transformer being connected with the so-called double-T connection. P^1_T, P^2_T, P^3_T, show the three conductors of the primary circuit, and S^1_T, S^2_T, S^3_T, show the three conductors of the secondary circuit. In this connection tap 4, which is connected to substantially the center point of winding 2 is connected to tap 6, which is connected to a point on the winding which gives substantially .866 of the number of the turns of the whole winding between it and the end of the winding 2′ connected to P^1_T, as is well understood in the art, with the so-called Scott two-phase three-phase connection. The taps 5 and 7 are connected to windings 3 3′ in a fashion similar to taps 4 and 6, and in this double-T connection are connected together.

Fig. 4 shows a connection for operating my transformer on a three-phase circuit with so-called open delta connection. P^1_D, P^2_D and P^3_D show the primary conductors of a three-phase circuit, and S^1_D, S^2_D and S^3_D show the secondary conductors of a three-phase circuit. The primary windings 2 and 2′ are both connected at one end to one conductor of the three-phase circuit, and at the other end are each connected to a conductor of the three-phase circuit. The secondary windings are similarly connected.

Fig. 5 shows a connection of my transformer for transforming from a two-phase current to a three-phase current. In this connection windings 2 and 2′ are connected to the primary conductors of the two phases P^1_2, P^2_2 and P^3_2, P^4_2, and the secondary wind-

ings 3 3′ are connected to the secondary conductors of the three-phase circuit S¹, S², S³, the taps 5 and 7 being connected together.

While I have not shown all the connections which may be made with my new form of transformer, many others may be made, which will be obvious to those skilled in the art. For example, my transformer may be operated for transforming from two-phase to two-phase by connecting the secondary windings 3 and 3′ each to one phase of a two-phase circuit in the same fashion as in Fig. 5 windings 2 and 2′ are connected. Also it will be obvious that while I have referred to and described certain of the windings as being primary and secondary, these windings may be reversed, if so desired, and also the transformation, as shown in Fig. 5, from two-phase to three-phase may be reversed, and my transformer may be used to transform a three-phase to a two-phase current.

While I have shown my transformer as having four legs, the center two of which alone are surrounded by a winding, I have only shown such a construction of transformer for the purpose of describing one embodiment of my invention, and it will be obvious to those skilled in the art that my invention is capable of many other embodiments, without departing from its spirit. It will also be obvious that the taps on the windings intermediate the ends of the windings may have their positions altered, if so desired, or additional taps may be employed, if it is desired to change the voltages on which my transformer is to operate.

I do not desire to limit myself to the particular construction and to the arrangement of windings which I have here shown, and changes which do not depart from my invention, and which are within the scope of the present claims will be obvious to those skilled in the art.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. The combination, in a transformer, of a core with a plurality of legs, primary and secondary windings surrounding certain of the legs, and connections on the primary and secondary windings for connecting the transformer for operation on current sources of variable numbers of phases.

2. The combination, in a transformer, of a core with a plurality of legs, certain of the legs surrounded each by a primary and a secondary winding, and connections on each winding intermediate the end connections for connecting the transformer for operation on current sources of variable numbers of phases.

3. The combination, in a core type of transformer, of a plurality of legs, two of the legs surrounded each by a primary and a secondary winding, and connections on each winding intermediate the end-connections for connecting the transformer for operation on current sources of variable numbers of phases.

4. The combination, in a core type of transformer, of a plurality of legs, two of the legs surrounded each by a primary and a secondary winding, and connections on each winding intermediate the end-connections so arranged that the transformer may be connected for operation on single-phase two-phase three-phase and three-phase two-phase circuits.

5. The combination, in a core type transformer of a core with four legs, a primary and a secondary winding each surrounding the two center legs of the core, and connections from each winding intermediate its end-connections for connecting the transformer for operation on single-phase two-phase three-phase or three-phase two-phase electric circuits.

In witness whereof, I have hereunto set my hand this 16th day of December, 1907.

JOHN J. FRANK.

Witnesses:

HELEN ORFORD,

MARGARET E. WOOLLEY.