

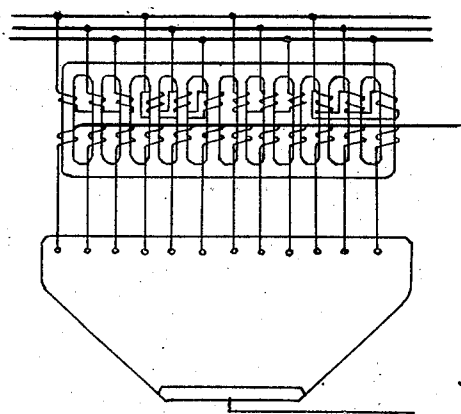
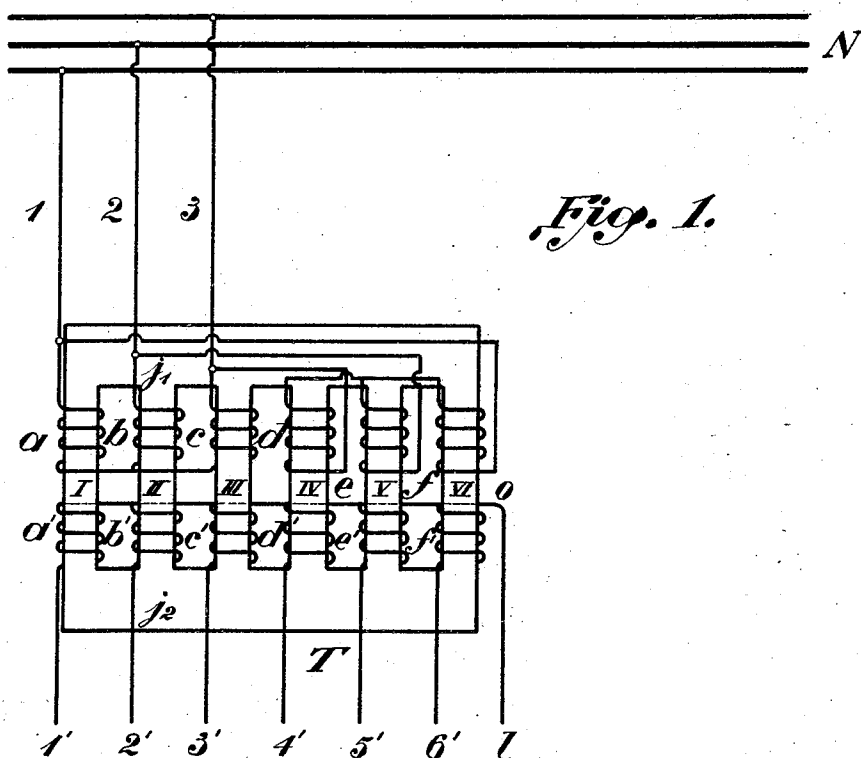
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TRANSFORMER FOR FEEDING POLYPHASE RECTIFIERS

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UNITED STATES PATENT OFFICE.

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TRANSFORMER FOR FEEDING POLYPHASE RECTIFIERS.

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For feeding a polyphase rectifier from a triphase supply circuit, it is customary to employ two or more three-limbed triphase transformers connected electrically in such a manner as to allow of taking polyphase current from the secondary winding of the transformers. In such arrangements, the secondary windings of the several transformers may have a common neutral point, while the primary windings may each be differently connected to produce the desired rotation of the secondary phases. Thus for instance, the primary winding of one transformer may be star-connected, that of the second transformer may be delta-connected, and that of the third transformer may be connected in zig-zag, and so on. The number of the primary connections varies with the number of the desired secondary phases.

Since the secondary windings of each of these transformers have a common neutral main, it is possible to produce large higher harmonic currents, and, as shown by the shapes of the curves for the anode currents of the rectifiers, there occur, above all, pronounced third harmonic currents.

In each transformer, the fluxes induced in the cores by the ampere turns corresponding to these higher harmonics have a common direction when viewed from the yoke end, whereas when considered from the point of view of the magnetic circuit they oppose one another. Each transformer core which constitutes a closed circuit with respect to the fundamental frequency currents flowing therein, is thus only a part of an open magnetic circuit with respect to the harmonic currents. Consequently, the choking field induced by the harmonics will be relatively weak and large harmonic currents will, as a result, circulate in the transformer.

A certain amount of choking is however produced by the leakage fields, but this choking effect is small, and is not sufficient to suppress the higher harmonic currents.

A strong choking of the higher currents could be produced by the use of a fourth unwound core for closing the magnetic circuit that is open as regards the higher third harmonic, so that a strong higher harmonic field can be formed. However, the provision of a fourth leg increases considerably the quantity of material required for, and also the cost of manufacture of, the transformer, es-

pecially as the standard types of construction are made with three legs only.

According to the present invention, a magnetic return circuit for the higher harmonic fields is provided by a combination of the several transformers into a single transformer having a greater number of legs. More particularly, the invention has thus for its object the provision of an improved transformer for feeding polyphase rectifiers from a triphase supply circuit, having as its chief characteristics a plurality of wound legs equal in number to a multiple of the number three and the arrangement of the legs in groups of three, with the windings thereon so connected that the magnetic fluxes corresponding to the higher third waves of one group will find a closed iron path in the core legs and yokes of different groups.

The invention will now be described more in detail with reference to the accompanying drawings which illustrate two embodiments thereof by way of example, Fig. 1 being for a six phase transformer, and Fig. 2 being for a twelve phase transformer.

In the drawing:—

N is a triphase supply circuit;

1, 2, 3 are the supply mains to the transformer T;

I, II, III, IV, V, and VI are the limbs of the transformer;

a, b, c, d, e, f , are the primary windings;

a', b', c', d', e', f' , are the secondary windings;

j_1, j_2 , are the yokes;

1', 2', 3', 4', 5', 6', are the supply leads to the anodes of the rectifier.

As shown, the improved transformer has six legs which number is a multiple of the number three. These legs form two triphase-excited groups; the legs I, II and III being excited by the triphase primary winding $a b c$; and the legs IV, V and VI being excited by the triphase winding $d e f$ in a direction opposite to the windings $a b c$. The secondary windings $a' b' c' d' e' f'$ constitute a six-phase system having a common neutral point O which is connected to the neutral main L, which is also the negative main of the direct-current supply circuit.

The six phases of the secondary winding result from the relative directions of the groups of primary windings to one another. As shown in the drawing, the directions of

the respective phases of the two groups of primary windings are 180° apart, and consequently the secondary winding will be a balanced six-phase winding. The two groups of legs I, II, III and IV, V, VI have the two common yokes j_1 and j_2 in common.

If we consider the direction of the ampere turns of the higher third harmonic waves on the legs of the two transformer groups, it will be perceived that, viewed from a yoke, the higher harmonic ampere turns comprised in each single group of legs have a common direction whereas, also viewed from the same point, the ampere turns in one group are directed oppositely from those in the other group, so that they have a completely closed magnetic circuit that is composed of the parallel legs I, II, III, the yoke j_1 , the parallel legs IV, V, VI and the yoke j_2 . Consequently the magnetic field of the third harmonic can develop to its full strength, and effectively choke the higher harmonic currents.

By combining a plurality of transformers, each of which constitutes a distinct closed magnetic circuit, into a common magnetic body, it is possible to provide closed magnetic circuits for the higher harmonic currents tending to flow in each transformer group. A strong choking field will thus be developed by the harmonics, thus effectively suppressing the same without excess of material and cost in the transformers.

What I claim is:—

1. A transformer for feeding polyphase rectifiers from a three-phase supply circuit including six core legs, arranged in groups of three, yokes common to said legs, a three-phase primary winding on each of said groups arranged as a one-phase winding on each leg, and a secondary winding on each of said legs, the groups of primary windings being so arranged that the E. M. F.'s of the

windings which are connected to the same main phase are in phase opposition, respectively to the same yoke, all the secondary windings being connected in symmetrical star connection, the free ends of said secondary windings being adapted to be connected to the respective anodes of a rectifier.

2. In transformer apparatus of the character described, a plurality of polyphase transformer groups, each of said groups having a core portion constituting in itself a substantially closed magnetic circuit with respect to the fundamental alternating currents, and a substantially open circuit with respect to certain harmonic currents tending to flow therein, the individual groups being so connected and the associated cores so combined with each other as to mutually constitute a closed magnetic circuit with respect to the higher harmonic currents tending to flow in the individual transformer groups.

3. In apparatus of the character described, a transformer having a star-connected polyphase secondary winding, said winding comprising a plurality of distinct balanced polyphase groups, magnetic core means associated with each of said groups and constituting a closed magnetic circuit with respect to fundamental-frequency currents flowing therein, the core means of each of said groups constituting portions of an open magnetic circuit with respect to higher harmonics tending to flow in the associated windings, the cores of the individual transformer groups and the associated windings being so connected that the incomplete magnetic circuit for the higher harmonics of one group is closed-circuited by the magnetic circuit of another group.

In testimony whereof I have signed my name to this specification.

JOHANN KÜBLER.