No. 728,970. PATENTED MAY 26, 1903.

J. S. PECK.

METHOD OF VARYING THE OUTPUT OF TRANSFORMERS.

APPLICATION FILED AUG. 4, 1902.

NO MODEL.

Fig. 1.

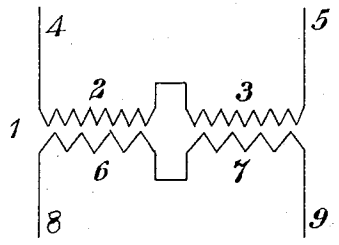


Fig. 3.

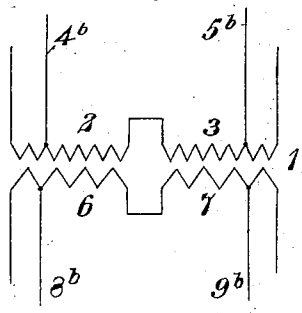


Fig. 2.

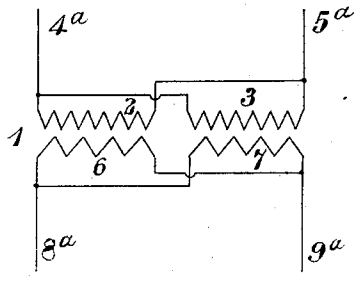


Fig. 4.

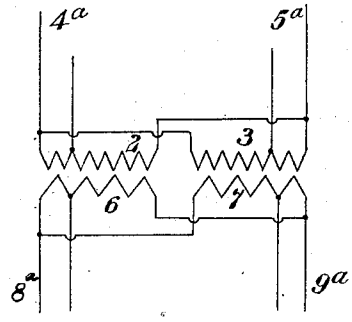


Fig. 5.

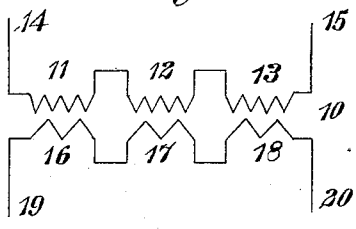
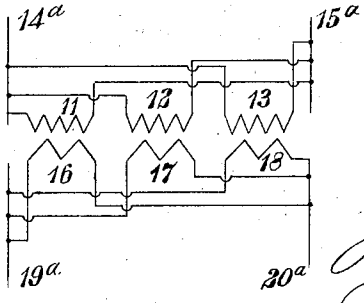


Fig. 6.



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UNITED STATES PATENT OFFICE.

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METHOD OF VARYING THE OUTPUT OF TRANSFORMERS.

SPECIFICATION forming part of Letters Patent No. 728,970, dated May 26, 1903.

Application filed August 4, 1902. Serial No. 118,383. (No model.)

To all whom it may concern:

Be it known that I, JOHN S. PECK, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of Varying the Output of Transformers, of which the following is a specification.

My invention relates to apparatus employed for transforming electrical energy of one voltage into energy of a different voltage; and it has for its object to provide a method of transformer design and operation whereby energy of one frequency may be transformed to provide a given output and whereby a change in frequency may be made to provide for a different output.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram of a transformer arranged and connected to provide a given output with a relatively low rate of alternations, and Fig. 2 is a similar view showing the connection of the windings for a higher rate of alternations and an increased output. Figs. 3 and 4 are views corresponding, respectively, to Figs. 1 and 2, but providing for the use of less than the entire length of winding for the lower frequency. Figs. 5 and 6 are views corresponding, respectively, to Figs. 1 and 2, but showing windings arranged for a greater difference between the two rates of alternations.

When the rate of alternations supplied to the primary winding of a transformer is increased, the induction in the core and the iron losses will be correspondingly reduced, provided no change is made in the transformer-windings. If the primary and secondary windings are each divided into a plurality of equal parts, the transformer may be operated at a lower rate of alternations with the parts of corresponding windings connected in series and at a higher rate of alternations with the parts of the windings connected in parallel, the induction being substantially the same at both rates of alternations. Assuming, for example, that the lower rate of alternations is three thousand six hundred per minute and the higher rate is seven thousand two hundred per minute and the parts of the respective windings are connected in series for the lower and in parallel for the higher rate, if each of the windings is divided into two parts the multiple connection will obviously provide one-half the number of electrical turns and double the cross-section of conductor. It follows, therefore, that the induction will be the same at both frequencies and that the transformer will deliver twice the output with no increase in copper loss. The iron loss will, however, be increased, and it is therefore necessary to design a transformer for this service with sufficient radiating-surface for disposing of the additional heat generated in the core at the higher frequency.

It is obviously not essential that the change in frequency shall be limited to that given as an example.

The design of a transformer for a greater range in rate of alternations is accompanied by a minimum degree of difficulty by reason of the fact that the higher the rate of alternations with the same winding the less will be the iron loss.

In Fig. 1 of the drawings the primary winding of a step-down transformer 1 is shown as comprising two parts 2 and 3, which are connected together in series and are supplied from a line-circuit 4 and 5. The secondary winding of the transformer 1 is also shown as comprising two equal lengths 6 and 7, which are connected together in series and to a distributing-circuit 8 9.

In Fig. 2 the two parts 2 and 3 of the primary winding of a transformer 1 are connected to supply-conductors 4^a and 5^a of a circuit the frequency of which is greater than that of the circuit 4 5, and the parts 6 and 7 of the secondary winding are also connected in parallel to supply a distributing-circuit 8^a and 9^a the frequency of which corresponds to that of circuits 4^a and 5^a.

It may be assumed, for example, as has already been done, that the rate of alternations of the circuit 4 5 is three thousand six hundred per minute and that the output supplied to the distributing-circuit 8 9 is one hundred kilowatts. If now the transformer be connected to the circuit 4^a and 5^a, the energy of which has a rate of alternations of

seven thousand two hundred per minute, the transformer may be utilized without any other changes in its construction than those indicated to provide an output to the distributing-circuit 8^a 9^a of two hundred kilowatts and, as above stated, without any increase in copper loss and without an increase in iron loss which cannot be properly taken care of by suitable provision of radiating-surface.

In Fig. 3 the transformer 1 is also shown as having a primary winding comprising two equal parts 2 and 3 and a secondary winding comprising two equal parts 6 and 7. Less than the entire length of the primary winding is, however, connected to the line-conductors 4^b and 5^b and correspondingly less than the entire length of the secondary winding is connected in circuit with the distributing line conductors 8^b and 9^b.

In Fig. 4, which illustrates the transformer arranged and connected for a higher rate of alternations, the entire lengths of the parts 2 and 3 of the primary winding are connected in parallel to the circuit 4^a 5^a, and the entire length of the parts 6 and 7 of the secondary winding are similarly connected to the distributing-circuit 8^a 9^a. This arrangement is adapted to cases where the difference between the higher and lower rates of alternations is not sufficient to warrant a reduction of fifty per cent. in the turns for the higher rate of alternations. With this arrangement the output at the higher frequency is in general less than twice that of the lower frequency. The desired adjustment may obviously be made to suit any difference in frequencies by providing leads at different points in the primary and secondary windings for connection to the external circuits of lower frequency.

In Fig. 5 the primary winding of the transformer 10 is divided into three equal parts 11, 12, and 13, which are connected in series to the supply-circuit 14 and 15, and the secondary winding of the transformer is similarly divided into three equal parts 16, 17, and 18, which are connected in series to the distributing-circuit 19 and 20.

In Fig. 6 the sections 11, 12, and 13 of the primary winding are shown as connected in parallel to a supply-circuit 14^a and 15^a of higher frequency than the circuit 14 and 15, and the lengths 16, 17, and 18 of the secondary winding are similarly connected to a distributing-circuit 19^a and 20^a of corresponding frequency.

The arrangement shown in Figs. 5 and 6 is adapted to cases in which the difference between the lower and the higher rates of alternations is very large—as, for example, a case in which the lower rate is three thousand alternations per minute and the higher sixteen thousand. With this arrangement the connection of the transformer-windings, as shown in Fig. 6, will provide an output three times as great as that from the arrangement and connections shown in Fig. 5.

While I have shown my invention as applied to step-down transformers, I desire it to be understood that it is also adapted to step-up transformers, as well as to those having a ratio of one to one.

It is to be further understood that the rates of alternations given and the numbers of equal parts into which the several windings are divided for connection in series and in parallel are merely illustrative and are not to be construed as limiting the invention to such details.

I claim as my invention—

1. The method of increasing the output of a transformer which consists in changing a plurality of substantially equal sections of corresponding windings from series to parallel connection and increasing the rate of alternations supplied to the primary winding.

2. The method of varying the output from an electrical transformer which consists in dividing each winding into a plurality of substantially equal sections and connecting the sections of each winding in series for a relatively low rate of alternations and output and connecting them in parallel for a relatively high rate of alternations and output.

3. The method of varying the output from an electrical transformer which consists in connecting a plurality of sections of each winding in series for a given rate of alternations and corresponding output and connecting said sections in parallel for a higher rate of alternations and thereby securing a correspondingly-increased output.

4. The method of varying the output from an electrical transformer which consists in connecting a plurality of sections of each winding in series for a given rate of alternations and a corresponding output and connecting a plurality of sections of each winding in parallel for a higher rate of alternations and a correspondingly-increased output.

5. The method of providing different outputs from an electrical transformer which consists in connecting a plurality of sections of each winding in series for a relatively low rate of alternations and a corresponding output and connecting a plurality of sections of each winding in parallel for a higher rate of alternations and a correspondingly-greater output.

In testimony whereof I have hereunto subscribed my name this 31st day of July, 1902.

JOHN S. PECK.

Witnesses:
JAMES B. YOUNG,
WESLEY G. CARR.