PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION
No. 16800 A.D. 1939.

Improvements in Stray-field Transformers

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JULIUS CATES, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to stray-field transformers, having high leakage reactance, and more especially to stray-field transformers of the type adapted to operate electric discharge devices without any series impedance.

If a stray-field transformer is to operate an assigned discharge device in an assigned manner, its voltage-current characteristic on the secondary side must be precisely determined. It is difficult to make transformers accurately to specification so that they all have the same characteristic; accordingly it is usual to provide in the design of the transformer some adjustable element, whereby the characteristic can finally be adjusted by trial.

In transformers of the type specified this adjustable element has hitherto usually been the "reactance irons". Thus, one well known kind of transformer is shown in Figures 1 and 2 of the accompanying drawing, Figure 1 being an elevation and Figure 2 a cross-section in the plane AA. The main core is built up of stampings in the form of a rectangular frame 1 with a central tongue 2 attached to the frame at one end 3, but not at the other end 4. The tongue is bent out of the plane of the frame and passed through the centres of the primary and secondary coils 5, 6; alternate tongues are passed through coils in opposite directions so that at each end of the transformer free ends 4 alternate with fixed ends 3. A gap 7 is left between the coils 5 and 6. Reactance irons 8 are then inserted into this gap on either side of the tongues 2, in a direction perpendicular to the plane of Figure 2. The number and width of these irons and the distance to which they penetrate into the gap are adjusted by trial, so that the magnetic reluctance of the iron path between the coils has the desired value and the characteristic of the ~~transformer~~ transformer has the desired form. Finally the reactance irons are held in position by wedges (not shown).

It is difficult to provide entirely satisfactory fixing means for the reactance irons. Accordingly the characteristic of the transformer may vary in use; and the transformer is apt to hum owing to the lack of rigidity. The object of the invention is to overcome these disadvantages.

According to the invention in the manufacture of a stray-field transformer, the whole of the core, including the reactance irons, is connected rigidly together and the final adjustment of the characteristic is made by moving the primary and secondary coils relative to each other. In order that the transformer shall be stable and free from hum, all that is then necessary is to secure the coils in their final position rigidly to the core.

Thus, in manufacturing according to the invention, a transformer of the kind shown in Figures 1 and 2, the number, width, and postion of the reactance irons 8 is determined once and for all; it is then easy to secure them rigidly to the frame 1. The apertures 9, 10 in the core in which the coils 5, 6 lie are made long enough to permit some movement of the coils towards and away from each other; the final adjustment is made by means of this motion. The coils are then fixed rigidly to the core, for example, by packing or wedging between the coils and the core.

One transformer manufactured in this manner will now be described in detail, by way of example, with reference to Figure 3 of the accompanying drawing.

The main core 1 is made of stampings of silicon transformer steel of the shape shown, all parallel to the plane of the figure. The dimensions marked by letters

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PRICE 2/-

are as follows:—

a	$6\frac{3}{4}$ inch.
b	$6\frac{1}{2}$ inch.
c	$4\frac{1}{2}$ inch.
d	2 inch.
e	$1\frac{3}{8}$ inch.
f	1 inch.

The pack of stampings is $3\frac{3}{4}$ inch in depth perpendicular to the plane of the drawing.

5 and 6 are respectively the primary and secondary coils, the former having 180 turns and the latter 480 turns the coils are insulated from each other. The dimension of the coils marked *g* is $1^{25}/_{32}$".

8 are the reactance irons of the same steel. They are strips $1^{11}/_{32}$ inch wide, so that, when they are placed as shown in an aperture on either side of the central tongue 2 of the main stampings with their planes perpendicular to those of the main stampings and to the long dimension of the aperture. a gap of $^{1}/_{64}$", indicated by *h*, can be left on either side of the reactance irons. The reactance irons were wedged in this position by electrically insulating packing in the gaps *h*. The length of the strips is approximately equal to the depth of the pack of main stampings. The dimension *j*, being the depth of the pack of reactance irons, is $\frac{7}{16}$ inch. Consequently, when the pack of reactance irons is in the centre of each aperture as shown, the coils 5 and 6 can each move to and from the other through a distance of $\frac{1}{4}$ inch.

230 volts at 50 cycles were applied to the primary coil. The open circuit secondary voltage was practically independent of the positions of the coils. When both coils were touching the reactance irons, the secondary short circuit current was about 6 amp.; on a secondary resistive load such that the secondary current was 1.75 amp, the secondary voltage was 452 volts.

When the primary coil was removed as far as possible from the reactance irons, but the secondary coil still touching them, the corresponding values were 5.4 amp and 1.75 amp at 446 volts.

When both primary and secondary coils were removed as far as possible from the reactance irons, the corresponding values were 4.9 amp. and 1.75 amp at 439 volts. Those skilled in the art will realise that these values enable sufficient adjustment to be obtained. When the appropriate position of the coils has been found by trial, the coils are packed in this position by insulating material inserted between them and the core on one side and the reactance irons on the other.

Since, in a transformer manufactured according to the invention. the reactance irons are wholly determinate, it is possible to make them part of the frame 1. This alternative is shown in Figure 4 of the accompanying drawing, which corresponds to Figure 1. The reactance irons 8 are now inward projections from the frame 1. It is still possible to thread the tongues 2 through the coils, as hereinbefore described, although the tongues may have to be bent further out of the plane of the frame in order to do so. The final adjustment is again made by sliding the coils 5 and 6 along the tongues 2.

Dated the 8th day of June, 1939.

NORMAN R. CAMPBELL.
For the Applicants.

PROVISIONAL SPECIFICATION
No. 17625 A.D. 1939.

Improvements in Stray-field Transformers

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JULIUS CATES, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to adjustable stray-field transformers of the type having a leakage path, partly or wholly of magnetic material, through which passes a substantial proportion of the flux linked with the primary (or secondary) winding which is not linked with the secondary (or primary) winding. The term adjustable implies that the ratio of the secondary to the primary voltage on load can be varied after the main part of the manufacture is completed, that is to say, without varying the constituents of the magnetic core or the number of turns in the primary and secondary coils. More particularly it relates to transformers of the said type adapted for use in the operation of electric discharge devices from alternating mains. It relates also to the manufacture of transformers of the said type.

In manufacturing transformers of the kind to which the invention relates more particularly, the characteristics have usually to be adjusted to close limits after the main process of manufacture is complete. The most usual procedure is to provide loose reactance irons, and to vary their number and/or position. An alter-

native method, recently proposed, is to fix the leakage path and to vary the position of the primary and secondary windings relative to each other and to the core. The object of this invention is to provide an alternative method which is, in some circumstances, more convenient than either.

According to the invention, in a transformer of the type specified the magnetic core is built up of stampings so shaped that there is an air or non-magnetic gap in the leakage path, but the magnetic part of the leakage path is integral with the magnetic part of the main path (i.e. the path traversed by the flux linked with both primary and secondary), the primary and secondary windings are both fixed relative to the core, and tappings are provided on the primary or on the secondary winding or on both. The adjustment is then made by choosing the tappings to which the input and output terminals are connected.

The condition that there must be a non-magnetic gap in the leakage path is necessary, because, if there were no such gap, it might be impossible to adjust by means of tappings the relation between secondary voltage and secondary current, which is of great importance when the transformer is used to operate a discharge device. There may or may not be a non-magnetic gap in the main path; but if there is such a gap in the main path, this gap is not to be regarded as being also in the leakage path. Thus, in the well known transformer, where the core has three parallel limbs extending between two bars, and the primary is wound on one limb and the secondary on another, the third limb is the magnetic part of the leakage path. If there is a gap at the end of a limb on which there is a winding, this gap lies in the main path and therefore not in the leakage path; but a gap at the end of the third limb would be in the leakage path.

Preferably the stampings are so shaped that they can be slipped into position within the primary and secondary windings. Thus one preferred form of stamping is shown in the accompanying drawing.

1 is a rectangular frame, 2 a tongue attached to it at one end 3, but free at the other end 4. These parts constitute the main path. The leakage path is constituted by the projections 5, together with the part of the tongue lying between them and the gaps between the projections and the tongue.

The primary and secondary windings are introduced into the apertures 6 and 7 respectively by lifting end 4 of the tongue 2 out of the plane of the drawing and slipping it through these windings. Preferably alternate stampings are slipped through in opposite directions, so that, in the completed pack, the ends 3 and 4 alternate at each end of the pack. The windings are provided with tappings in the usual manner.

Dated the 16th day of June, 1939.

NORMAN R. CAMPBELL,
For the Applicants.

PROVISIONAL SPECIFICATION
No. 5020 A.D. 1940.

Improvements in Stray-field Transformers

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JULIUS CATES, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to stray-field transformers having high leakage reactance, and more especially to stray-field transformers of the type adapted to operate electric discharge devices without any series impedance.

In co-pending applications Nos. 16800/39 and 17625/39 it is proposed to adjust the characteristic of such transformers, not (as has been usual) by adjustment of the "reactance irons", but by adjustment of the primary and/or secondary coils. In the first of the said applications the adjustment was a motion of the primary and secondary coils relative to each other; in the second the adjustment was a choice between tappings on one or both coils.

In Application No. 17625/39, it was prescribed that there must be an air or non-magnetic gap in the leakage path, that is to say with a path traversed by a substantial proportion of the flux linked with the primary (or secondary) winding which is not linked with the secondary (or primary) winding. In Application No. 16800/39 it was not stated explicitly that such a gap was necessary, but in all the examples described a gap was actually present.

We have now found that such a gap is neither always necessary nor always desir-

able. It is usually desirable and may sometimes be necessary when the adjustment is by relative motion of the coils; but it is seldom, if ever, necessary when the adjustment is by tappings, and may not then be desirable.

According to one aspect of the invention in a stray-field transformer otherwise in accordance with the invention described in the said co-pending applications, there is no gap in the leakage path, that is to say no place where the flux traversing the leakage path emerges from material of high magnetic permeability into material of very much less permeability at a surface substantially perpendicular to its direction.

It might be thought that, although a gap is not necessary to the satisfactory performance of the transformer, it was necessary to its construction, at least when there are no separate reactance irons, in order that the magnetic core might be introduced within the coils. Actually a gap can be avoided in known manner by placing the leakage path, not between the two coils, but outside both of them. However we will describe, with reference to the accompanying drawing, how a transformer may be constructed, not differing greatly from those described in the said application, in which there is no gap in the leakage path.

The core is built up from two sets of stampings, denoted respectively by (*a*) and (*b*) in the drawing. Stampings (*a*) are generally similar to those described with reference to Figure 1 of Application No. 16800/39, consisting of a complete frame 1a and a tongue 2a attached to the frame at one end but free at the other. Stampings (*b*) differ from these in the absence of the part of the frame at the free end of the tongue. 5, 6 are the positions of the two coils. The lengths denoted by L_a and L_b are equal. In building up the transformer, a stamping (*a*) is fitted round the coil 5, and a stamping (*b*) round the coil 6, the tongues being introduced into the coils from right to left, so that the stampings occupy the positions shown in the drawing. Next a stamping (*b*) is fitted round the coil 5 and a stamping (*a*) round the coil 6, the tongues being introduced from left to right, so that the stampings occupy the positions which would be shown if the drawing were turned end for end. This pair of steps is repeated until the complete core is built up. The result will be that the gaps *k* in one layer are covered by the part 8 of a frame (*a*) in the next; these parts 8 play the part of reactance irons and occupy the leakage path. Accordingly, though some small part of the flux traversing the leakage path lies in the spaces between the parts 8, there is no gap interrupting the flux.

The gaps at *m* are in the main magnetic path; they may or may not be covered by the parts of stampings (*b*) to which the tongue is attached.

According to another aspect of the invention, in a combination of an electric discharge device and a stray-field transformer adapted to operate it, the said transformer is of the kind described in one of the two said co-pending applications according to the first aspect of this invention.

Dated the 18th day of March, 1940.
NORMAN R. CAMPBELL,
For the Applicants.

COMPLETE SPECIFICATION

Improvements in Stray-field Transformers

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and JULIUS CATES, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to stray-field transformers of the type having a leakage path, mainly or wholly of magnetic material, through which passes a substantial proportion of the flux linked with the primary (or secondary) winding which is not linked with the secondary (or primary) winding, and adapted, when its primary is fed from alternating mains, to operate an assigned electric discharge device continuously in an assigned manner. It relates also to the manufacture of a transformer of the said type, and to combinations of a transformer of the said type with an electric discharge device operated by it.

If a stray-field transformer is to operate an assigned discharge device in an assigned manner, its voltage-current characteristic on the secondary side must be precisely determined. It is difficult to make transformers accurately to specification so that they all have the same charac-

teristic; accordingly it is usual to provide in the design of the transformer some adjustable element, whereby the characteristic can finally be adjusted by trial, and in particular so that the secondary current through a prescribed load can be adjusted without any substantial alteration in the open circuit secondary voltage.

In transformers of the type specified this adjustable element has hitherto usually been the "reactance irons". Thus, one well known kind of transformer is shown in Figures 1 and 2 of the drawing accompanying provisional specification No. 16800/39, Figure 1 being an elevation and Figure 2 a cross-section in the plane AA. The main core is built up of stampings in the form of a rectangular frame 1 with a central tongue 2 attached to the frame at one end 3, but not at the other end 4. The tongue is temporarily bent out of the plane of the frame and passed through the centres of the primary and secondary coils 5, 6; alternate tongues are passed through coils in opposite directions so that at each end of the transformer free ends 4 alternate with fixed ends 3. A gap 7 is left between the coils 5 and 6. Reactance irons 8 are then inserted into this gap on either side of the tongues 2, in a direction perpendicular to the plane of Figure 1. The number and width of these irons and the distance to which they penetrate into the gap are adjusted by trial, so that the magnetic reluctance of the iron path between the coils has the desired value and the characteristic of the transformer has the desired form. Finally the reactance irons are held in position by wedges (not shown).

It is difficult to provide entirely satisfactory fixing means for the reactance irons. Accordingly the characteristic of the transformer may vary in use; and the transformer is apt to hum owing to the lack of rigidity. The object of the invention is to overcome these disadvantages.

According to the invention in the manufacture of a stray-field transformer of the type specified, the whole of the magnetic core, including the reactance irons, is connected rigidly together and the final adjustment of the characteristic is made by adjusting the primary or the secondary coil or both. The adjustment of the coils can be made in a way that leaves little opportunity for subsequent change, either progressive and giving rise to a change of the characteristic or cyclical and giving rise to hum.

Two methods of adjusting the coil(s) are convenient. One is to move the two coils relative to each other; the other is to change the effective number of turns in one or both coils by providing the coil with tappings near one end and choosing one of these tappings as the end of the coil for permanent use.

If the first method is adopted in manufacturing a transformer of the kind shown in the said Figures 1 and 2, the number, width, and position of the reactance irons 8 is determined once and for all; it is then easy to secure them rigidly to the frame 1. The apertures 9, 10 in the core in which the coils 5, 6 lie are made long enough to permit some movement of the coils towards and away from each other; the final adjustment is made by means of this motion. The coils are then fixed rigidly to the core, for example, by packing or wedges between the coils and the core.

Two transformers manufactured in this manner will now be described in detail, by way of example, one with reference to Figure 3 of the drawing accompanying provisional specification No. 16800/39 and the other with reference to Figure 5 of the accompanying drawing. In all of the said Figures 1, 3, 5 corresponding parts are represented by the same numeral.

In the embodiment of Figure 3, the main core 1 is made of stampings of silicon transformer steel of the shape shown, all parallel to the plane of the figure. The dimensions marked by letters are as follows:—

a	$6\frac{3}{4}$ inch.
b	$6\frac{1}{2}$ inch.
c	$4\frac{1}{2}$ inch.
d	2 inch.
e	$1\frac{3}{8}$ inch.
f	1 inch.
g	$1^{25}/_{32}$ inch.

Each stamping is 0.014 in. thick and carries a thin insulating layer on one side. The pack of stampings is $3\frac{3}{4}$ inch in depth perpendicular to the plane of the drawing.

5 and 6 are respectively the primary and secondary coils wound on bobbins, the former having 180 turns and the latter 480 turns; the transformer is double-wound and the coils are insulated from each other.

8 are the reactance irons of the same steel. They are strips $1^{11}/_{32}$ inch wide, so that, when they are placed as shown in an aperture on either side of the central tongue 2 of the main stampings with their planes perpendicular to those of the main stampings and to the long dimension of the aperture, a gap of $^{1}/_{64}$" can be left, indicated by *h*, on either side of the reactance irons. The reactance irons were wedged in this position by electrically insulating packing in the gaps *h*.

The length of the strips is approximately equal to the depth of the pack of main stampings. The dimension j, being the depth of the pack of reactance irons, is $\frac{1}{16}$ inch. Consequently, when the pack of reactance irons is in the centre of each aperture as shown, the coils 5 and 6 can each move to and from the other through a distance of $\frac{1}{4}$ inch.

250 volts at 50 cycles were applied to the primary coil. The open circuit secondary voltage was 590 and was practically independent of the positions of the coils. When both coils were touching the reactance irons 8, the secondary short circuit current was about 6 amp.; on a secondary resistive load such that the secondary current was 1.75 amp., the secondary voltage was 452 volts.

When the primary coil was removed as far as possible from the reactance irons, the corresponding values were 5.4 amp. and 1.75 amp. at 446 volts.

When both primary and secondary coils were removed as far as possible from the reactance irons, the corresponding values were 4.9 amp. and 1.75 amp. at 439 volts. Those skilled in the art will realise that these values enable sufficient adjustment to be obtained. When the appropriate position of the coils has been found by trial, the coils are packed in this position by insulating material inserted between them and the core on one side and the reactance irons on the other.

Since, in a transformer manufactured according to the invention, the position and form of the reactance irons are wholly determinate, it is possible to replace them by parts integral with the main part of the core. This alternative is shown in Figure 4 of the drawing accompanying provisional specification No. 16800/39. The reactance irons 8 are replaced by inward projections from the frame 1. It is still possible to thread the tongues 2 through the coils, as hereinbefore described, although the tongues may have to be bent temporarily further out of the plane of the frame in order to do so. The final adjustment is again made by sliding the coils 5 and 6 along the tongues 2.

In the particular embodiment to be described in which such stampings are used, their dimensions shown in Figure 5 are as follows:—

a	$4\frac{1}{8}$ inch.
b	6 inch.
c	$4\frac{13}{16}$ inch.
d	$1\frac{3}{16}$ inch.
e	$\frac{7}{8}$ inch.
f	$\frac{19}{32}$ inch.
g	$1\frac{5}{8}$ inch.

The pack of stampings is $2\frac{5}{8}$ inch in depth.

5 and 6 are respectively the primary and secondary coils; each consists of 570 turns of 20 S.W.G. enamelled copper wire. The coils are auto-connected. The reactance parts of the core 8 are placed centrally; the dimension j is $\frac{3}{4}$ inch, the air gap h is 0.025 inch. Each coil can thus move $\frac{13}{32}$ inch.

260 volt 50 cycles were applied to the primary coil. The open circuit secondary voltage was 485 and practically independent of the position of the coils.

When both coils were touching the reactance projections 8, the secondary short-circuit current was 1.045 A; with a secondary resistive load such that the secondary current was 0.9 A the secondary voltage was 155 volt. When both coils were removed as far as possible from the reactance projections the secondary short circuit current was 0.965 A; with a secondary resistive load giving a current of 0.9 A the secondary voltage was 110 volt.

If the second method is adopted, the primary and secondary coils should be fixed in position before the adjustment by means of the tapping starts. It is then unnecessary to provide more room for the coils to move in the space they occupy than is required to introduce the coils.

One transformer manufactured according to the second method will now be described in detail.

The core, including the dimensions a—f and h, j, is the same as in the embodiment described with reference to the said Figure 5. The bobbins of the coils are now of slightly different dimensions; for the primary coil 5 the dimension g is $1\frac{3}{4}$ inch, for the secondary coil 6 $1\frac{1}{8}$ inch. They are packed centrally in the spaces they occupy; they are auto-connected.

The tappings are arranged as shown in Figure 6 of the accompanying drawing. The primary coil has 491 turns of $19\frac{1}{2}$ S.W.G. enamelled copper wire between the points a, B, 6 turns between a, b, and 6 turns between b, c. The secondary coil has 569 turns of 20 S.W.G. enamelled copper wire between a^1, C, 7 turns between a^1, b^1, 7 turns between b^1, c^1. The secondary open circuit voltage for given primary voltage has to have a predetermined value; accordingly, when the tappings are changed, the number of effective turns in the primary coil must be increased or decreased as the number of effective turns in the secondary coil is increased or decreased. Thus either a, a^1 or b, b^1 or c, c^1 will be connected to each other and to the terminal A. The primary voltage is applied between A and B; the secondary load is connected between B and C.

When 240 volts 50 cycle A.C. was applied to the primary, the open circuit secondary voltage was about 450 whether A was connected to a, a^1 or to b, b^1 or to c, c^1. When a, a^1 were connected to A, the short circuit current was 0.965 amp.; when the current through a resistive secondary load was adjusted to be 0.9 amp.; the secondary voltage was about 110 volts. When b, b^1 were connected to A, the values corresponding to 0.965 and 110 were 1.005 and 133; when c, c^1 were connected to A, the corresponding values were 1.045 and 155. It will be realised by experts that the range and sensitivity of the adjustment provided by the tappings will be sufficient in normal circumstances.

The tapping shown at D in Figure 6 is the usual tapping for permitting a different primary voltage (e.g. 230) to be used. It is not a tapping characteristic of the invention.

It may be noted that, if the condition that the secondary open circuit voltage is to have a predetermined value for given primary voltage were not imposed, tappings might be provided on one coil only.

In all the three transformers hitherto described there is a non-magnetic gap h in the leakage path. As indicated by the word "wholly" in the description of the type to which the invention relates, the presence of such a gap is not always necessary. It may sometimes be necessary if the first method of adjustment is adopted; for, in its absence, relative motion of the coils may produce little change of the characteristic. But it is not necessary, and may not be desirable for the operation of the transformer, if the adjustment is by tappings. However it might be thought that a gap was necessary for constructional reasons in order that the core may be introduced within the gap. Actually a gap can be avoided in known manner by placing the leakage path, not between the two coils, but outside both of them. But we will describe, with reference to Figure 7 of the accompanying drawing, how a transformer may be constructed, not differing greatly from those described in the said application, in which there is no gap in the leakage path.

The core is built up from two sets of stampings, denoted respectively by (a) and (b) in the drawing. Stampings (a) are generally similar to those described with reference to Figure 1 of Application No. 16800/39, consisting of a complete frame 1a and a tongue 2a attached to the frame at one end but free at the other. Stampings (b) differ from these in the absence of the part of the frame at the free end of the tongue. 5, 6 are the positions of the two coils. The lengths denoted by L_a, L_b are equal. In building up the transformer, a stamping (a) is fitted round the coil 5, and a stamping (b) round the coil 6, the tongues being introduced into the coils from right to left, so that the stampings occupy the positions shown in the drawing. Next a stamping (b) is fitted round the coil 5 and a stamping (a) round the coil 6, the tongues being introduced from left to right, so that the stampings occupy the positions which would be shown if the drawing were turned end for end. This pair of steps is repeated until the complete core is built up. The result will be that the gaps k in one layer are covered by the part 8 of a frame (a) in the next; these parts 8 play the part of reactance irons and occupy the leakage path. Accordingly though some small part of the flux traversing the leakage path lies in the spaces between the parts 8, there is no gap interrupting the flux.

The gaps at m are in the main magnetic path; they may or may not be covered by the parts of stampings (b) to which the tongue is attached.

Pairs of different mutually complementary stampings, related similarly to (a) and (b) in the said Figure 7 may sometimes be employed conveniently even when there is a gap in the leakage path. Such a pair is shown in Figure 8 of the accompanying drawing, which requires little description. As before the positions of the parts (a) and (b) are reversed in successive layers. The gaps l in one layer are then covered by the parts l^1 in the next; but the gaps h continue throughout the layers.

When two secondaries are to be associated with a single, primary stampings of the form shown in Figure 9 of the accompanying drawing may be used. Here again 1 is the frame, 2 the tongue attached to the frame at one end but free at the other, 11 and 11^1 two sets of projections. The primary coil lies in the central space 12, the secondaries in the two spaces 13, 14 or either side of it.

Our attention has been drawn to Patent Specification No. 245,069, which describes a stray-field transformer, suitable for arc welding, having a leakage path of the kind described in the statement of the type to which the present invention relates. Its characteristic feature is the provision of a multi-step switch (modifying the primary winding in the examples particularly described) in such a manner that increase of the welding current (which is apparently the secondary current through a small load) is accompanied by decrease of the open

circuit secondary voltage and *vice versa*. It is apparently intended that the switch should be moved from one step to another between different welding operations.

As has been already indicated by a general statement of the examples an adjustment of the characteristic so that this condition is fulfilled is not likely to be required in transformers of the type specified, which are not intended to be adjusted by the user, but are adjusted once and for all by the makers (except possibly for adaptation to different mains voltages) so as to operate an assigned discharge device in an assigned manner. Accordingly we exclude from the scope of our invention any method of manufacturing a transformer, otherwise in accordance with the invention, in which, during the final adjustment of the characteristic, a change of the secondary current through the assigned load is always accompanied by a substantial change in the opposite direction of the open circuit secondary voltage, and also any transformer manufactured by the excluded method.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim (subject to the foregoing disclaimer) is:—

1. The method of manufacturing a stray-field transformer of the type specified wherein the whole of the magnetic core, including the reactance irons (if any), is connected rigidly together and the final adjustment of the characteristic is made by adjusting the primary or the secondary or both relative to each other.

2. The method according to Claim 1 wherein the adjustment is made by moving the primary and secondary coils relative to each other.

3. The method according to Claim 1 wherein the adjustment is made by providing tappings near the end of one or both coils and choosing one of these tappings as the end of the coil for permanent use.

4. The method according to Claim 1, 2, or 3 wherein parts performing the function of reactance irons are integral with the main part of the core.

5. The method according to Claim 4 wherein the core is built of stampings having one or other of the forms shown respectively in Figure 4 of the drawing accompanying provisional specification No. 16800/39, in Figure 7, in Figure 8 and in Figure 9 of the accompanying drawing.

6. A stray-field transformer manufactured according to any preceding Claim.

7. A stray-field transformer according to Claim 6 whose parts are constructed substantially as hereinbefore described with reference to Figure 3 of the drawing accompanying provisional specification No. 16800/39 or with reference to Figure 5 of the accompanying drawing or with reference to both Figure 5 and Figure 6 of the accompanying drawing.

8. A combination of an electric discharge device with a transformer adapted to operate it in a prescribed manner wherein the said transformer is according to Claim 6 or Claim 7.

Dated the 2nd day of April, 1940.

NORMAN R. CAMPBELL,
For the Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1940.

circuit secondary voltage and *vice versa*. It is apparently intended that the switch should be moved from one step to another between different welding operations.

As has been already indicated by a general statement of the examples an adjustment of the characteristic so that this condition is fulfilled is not likely to be required in transformers of the type specified, which are not intended to be adjusted by the user, but are adjusted once and for all by the makers (except possibly for adaptation to different mains voltages) so as to operate an assigned discharge device in an assigned manner. Accordingly we exclude from the scope of our invention any method of manufacturing a transformer, otherwise in accordance with the invention, in which, during the final adjustment of the characteristic, a change of the secondary current through the assigned load is always accompanied by a substantial change in the opposite direction of the open circuit secondary voltage, and also any transformer manufactured by the excluded method.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim (subject to the foregoing disclaimer) is:—

1. The method of manufacturing a stray-field transformer of the type specified wherein the whole of the magnetic core, including the reactance irons (if any), is connected rigidly together and the final adjustment of the characteristic is made by adjusting the primary or the secondary or both relative to each other.

2. The method according to Claim 1 wherein the adjustment is made by moving the primary and secondary coils relative to each other.

3. The method according to Claim 1 wherein the adjustment is made by providing tappings near the end of one or both coils and choosing one of these tappings as the end of the coil for permanent use.

4. The method according to Claim 1, 2, or 3 wherein parts performing the function of reactance irons are integral with the main part of the core.

5. The method according to Claim 4 wherein the core is built of stampings having one or other of the forms shown respectively in Figure 4 of the drawing accompanying provisional specification No. 16800/39, in Figure 7, in Figure 8 and in Figure 9 of the accompanying drawing.

6. A stray-field transformer manufactured according to any preceding Claim.

7. A stray-field transformer according to Claim 6 whose parts are constructed substantially as hereinbefore described with reference to Figure 3 of the drawing accompanying provisional specification No. 16800/39 or with reference to Figure 5 of the accompanying drawing or with reference to both Figure 5 and Figure 6 of the accompanying drawing.

8. A combination of an electric discharge device with a transformer adapted to operate it in a prescribed manner wherein the said transformer is according to Claim 6 or Claim 7.

Dated the 2nd day of April, 1940.

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