This invention relates to control devices for protecting the windings of electric transformers against overload by intentionally increasing the magnetic leakage of the transformer.

The device according to the invention is distinguished by providing the iron body of the transformer with a core and two legged yokes and arranging on said core a primary and a secondary winding side by side with an intervening space and inserting in said space a magnetic leakage conducting means extending transversely of the core and interconnecting the latter with the legged ends of said yoke magnetically, the cross-section of said transverse means being smaller than that of the core and the latter carrying the two windings separately on opposite sides of said leakage conducting means.

In the accompanying drawing two typical embodiments of the invention are schematically illustrated, each embodiment representing a shell type transformer for monophase and three phase alternating current systems respectively and differing in regard to the arrangement of the leakage control means incorporated therewith. In the drawing

Fig. 1 shows an elevation of the first embodiment comprising leakage control plate elements that are mortised in the iron body of the transformer, the transformer windings and the direction of the leakage fluxes being also indicated;

Fig. 2 shows a cross section of Fig. 1 through the core, the legs of the yokes and the leakage control member, the latter interconnecting the core with the legs;

Fig. 3 shows a view similar to Fig. 2 of a modified construction of the iron body, leakage control members being provided on the one hand to interconnect the core and the legs interiorly between these parts and on the other hand exteriorly i.e. laterally of the core;

Fig. 4 shows an exploded view mating portions of a complete element of the iron body for the section thereof which is devoid of leakage control members;

Fig. 5 shows in an exploded view mating portions of a complete element of the iron body for the sections thereof including an interior leakage flux deviating member;

Fig. 6 shows in an exploded view mating portions of a complete element of the iron body for the sections thereof including exterior leakage control members;

Fig. 7 illustrates a diagram indicating the secondary voltages in function of the secondary currents of the transformer frame at all times and consequently permits to reduce the number of but joint loss reducing ampero-turns and brings about the result that, due to the overlapping plate element portions provided by the mortised joints Z1 and Zk, on insertion of the leakage control device for electric transformers.

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Renewed April 20, 1938. In Switzerland February 6, 1934

4 Claims. (Cl. 171--119)

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Plate elements a minimum of deviations from the nominal magnetic conducting properties of the leakage control shunt across the legs of the transformer and provided that the frame of the latter is assembled as standard intersecting pieces.

Now, if an alternating voltage is impressed on the primary winding P, in the core portion encompassed by this winding a magnetic flux $\Phi$ is generated the major part of which passes through the leg portions of the transformer frame and back through the core portion of the secondary winding S, and which, already at no load, causes a small magnetic leakage flux $\Phi_0$ to flow through the leakage control member $S$ in accordance with the cross-sectional area and the magnetic resistance of this member. On loading the secondary up to the limit of a short circuit, the magnetic flux generated by the secondary current counteracts the main magnetic flux in the core of the secondary winding until a relation between the magnetic fluxes $\Phi$ and $\Phi_0$ passing through the core portion of the secondary and through the leakage control member respectively, is reached which is inversely proportional to the magnetic resistance of the respective two paths of the lines of force. Therefore, in the event of the secondary being overloaded, so as to normally invite a short circuit, the secondary current can rise in value only until the said relation is permanently established, so that by correspondingly choosing the areas of cross-section of the leakage control member and the material of this member the secondary current can be regulated to a desired maximum value.

Experiments have shown that the more the butt joint loss reduction ampere turns of the leakage control members can be reduced and depending on which magnetic material is selected for the said members and on the manner in which these members are inserted entirely different characteristic shapes of the secondary voltage drop curves ensue. It has further been found by experiments that the number of butt joint loss reduction ampere turns can be reduced to a minimum by means of the described arrangement of the leakage control members, so that also the drop in the secondary voltage is correspondingly reduced in a similar manner as obtained by means of the hitherto used methods.

When it is required to keep the drop in voltage small for a certain range of loading, the leakage control members are to be inserted between the core portions and the legs of the transformer in a similar manner as shown in Fig. 2 and furthermore, and this may be taken to the provision of varying the magnetic structural material for the leakage control members in respect of the material used for the transformer frame or proper in accordance with the degree of safety to be attained in regard to the possibility of a short circuit arising. As such structural materials for the leakage control members different alloys of transformer iron may be used for example chrome iron, iron containing nickel or nickel together with chrome, or else sheet nickel or like materials or alloys. In every case it is, however, indispensable that the leakage control plate elements be of the same thickness as the plate elements of the transformer frame.

The arrangement of the mortised in leakage control members as described and the employment of different magnetic materials for the purpose of keeping down the maximum values of secondary current is applicable to all usual transformers of the shell type of any desired output capacity. For high capacity transformers the necessity arises for subdividing the windings. If the drop in voltage is not limited to a certain amount subdivision may be used which provides for interior and exterior leakage control members, the interior members again interconnecting the core with the legs in between these parts and the exterior members extending laterally of the core between the same and raised portion of the legs as shown in Fig. 3. Alternatively exterior leakage control members alone may be used which construction results in a drop in voltage as represented by the curves I and 3 in Fig. 7.

Controlling the magnetic properties of the transformer in close conformity to actual conditions can be obtained by applying different magnetic materials for constructing the leakage control members in combination with the material used for the active parts of the iron body. In manufacturing the iron body of shell type transformers on a large scale, advantageously bipartite plate elements with the tenons Z1 and Z2 interengaging one another in offset relation are used for the body proper, the tenons on either one of two mating plate elements being cut off at P for facilitating the insertion of the leakage control members, as shown in the Figs. 5 and 6. This construction permits of using like plate elements for the body of usual transformers as well as for transformers with leakage control members according to the invention.

The iron body of the shell type transformer for monophase alternating current, as described, can be used also for constructing a five-legged three-phase transformer with leakage control plates inserted between the legs and cores by assembling two such iron bodies placed side by side, as evident from the Figs. 8 and 9, the three inner legs serving as cores for the primary and secondary windings and the two exterior legs as compensating yokes. The direction of the leakage fluxes are again indicated by arrows to pass either from certain cores to the legged yokes or between cores. Also for such five-legged three-phase transformers the leakage control members may be constructed of other magnetic materials than the cores and the yokes, as explained above, only interior leakage control members being however used as a rule for this transformer type since the exterior leakage control plates represent some constructional measures and usually result in a considerable drop in voltage.

The leakage control members as provided for according to the invention for keeping down the maximum value of the secondary current are applicable in practice to all five-legged three-phase transformers of any output capacity, subdividing the winding being required also here for the higher transformer capacities.

Transformers according to the invention the magnetic leakage of which is intentionally increased are applicable in all cases where in an electric circuit current impulses of an undue magnitude are apt to arise or the employment of ordinary fuses is inadequate for some reason or other and thus special protecting means for the windings are required. Moreover, the crowded construction these transformers may be used to particular advantage for electric welding installations. Furthermore, these transformers of abnormally high magnetic leakage may be applied to advantage for any electric installations which may suddenly be unduly overloaded.
of abnormally high magnetic leakage can be used to advantage in all cases where it is intended to distribute the load on an electric plant to several phases in order to obtain a more uniform loading of the network. This necessity arises for example if a number of hand lamps are to be supplied by a single transformer at the same time and different groups of such lamps are distributed over the various working places. The construction of the five-legged transformer with three pairs W of windings P and S, shown in the Figs. 8 and 9, provides a three-phase transformer with a characteristic of each phase equivalent to that of a monophase shell type transformer, the magnetic flux of which is intentionally increased. The three phases of this transformer may be combined by any suitable mode of switching, for the purpose of transforming three-phase to monophase alternating current or three-phase alternating current to monophase alternating current by an intentionally increased magnetic leakage with a minimum amount of material and labor.

I do not limit myself to the particular size, shape, number or arrangement of parts as shown and described, all of which may be varied without going beyond the scope of my invention as shown, described and claimed.

What I claim is:

1. In a control device for protecting the windings of electrical transformers against overload, in combination, an iron body of the transformer, a core and mating legged yokes comprised by said body, said yokes adjoining each other at the outer ends of their legs and holding said core to extend longitudinally of said legs centrally between the latter, said core and yokes of said body being of a shape to provide a shell type transformer, tenons provided in said core by the adjoining outer ends of said legs, a primary and a secondary transformer winding arranged on said core side by side and separated by an intervening space, a magnetic leakage conducting control member extending transversely of said core through said space and magnetically interconnecting said core with said legs, said control member comprising rectangular collateral plate elements each mortised into a correld leg element of said body so as to be prevented from sideward displacement relative to said legs without the aid of fastening means, the cross-section of said control member being smaller than that of said core.

2. In a control device for protecting the windings of electrical transformers against overload, the combination with a five-legged bipartite iron body of a transformer of the shell type, each part of said body comprising a core and two mating legged yokes, said yokes adjoining each other at the outer ends of said legs and holding said core to extend longitudinally of said legs centrally between the same, the cores and yokes of each part of said body being of a shape to provide an individual shell type transformer, interengaging tenons provided at the adjoining outer ends of the legs, said parts being assembled side by side so that the adjacent legs of said two parts form together a central core of said five-legged body, a primary and a secondary transformer winding arranged on the core of each of said parts and of said central core side by side and separated by intervening spaces, and a magnetic leakage conducting control member for each of said parts extending as a continuous control member transversely of said three cores through said intervening spaces for magnetically interconnecting the three cores with the outer legs, each control member comprising rectangular collateral plate elements, each of said plate elements being mortised into a correld leg element of the respective part of said body, so as to be prevented from sideward displacement relative to said latter element, and the cross-section of said control member being smaller than that of each of said cores, the whole arrangement providing a three-phase transformer having the characteristic that the magnetic leakage of each phase is equivalent to that of a monophase shell type transformer the magnetic leakage of which has been intentionally increased.

3. In a control device for protecting the windings of electrical transformers against overload, the combination with an iron body of the transformer shaped to provide a shell type construction, said body consisting of a core and two mating legged yokes, said yokes joining each other at their outer ends and arranged to hold said core in a position extending longitudinally of said legs centrally therebetween, of transformer windings distributed on said core, both said core and said windings being interrupted to provide an intervening space, and a magnetic leakage conducting control member extending transversely of said core through said space and magnetically interconnecting said core with said legs, said control member consisting of a plurality of elements with end portions each mortised into a correld leg element of said body whereby there is imparted the magnetic advantage of providing reduced reluctance at the joint and the mechanical advantage of preventing sidewise displacement relative to said legs without the aid of fastening means.

4. In a control device for protecting the windings of electrical transformers against overload, the combination with a main magnetic body member shaped to provide a shell type transformer construction, said body member consisting of a laminated core and two laminated mating legged yokes, of transformer windings distributed on said core, and an auxiliary magnetic member for conducting and controlling magnetic leakage, said auxiliary member consisting of a plurality of laminated elements disposed in the planes of said main body laminations and extending transversely of said core and magnetically interconnecting said core and said legged yokes at intermediate points through butt joint constructions; at least one of said butt joint constructions being characterized by the provision of a recess in the abutting member and a terminal portion of said auxiliary magnetic member mortised into the recess whereby there is imparted the magnetic advantage of providing reduced reluctance at the joint and the mechanical advantage of preventing sidewise displacement in the plane of the laminations at the joint.

EMIL WIRZ.