Aug. 10, 1937. E. D. T. NORRIS 2,089,926

MOVING COIL VOLTAGE REGULATOR

Filed Sept. 27, 1935

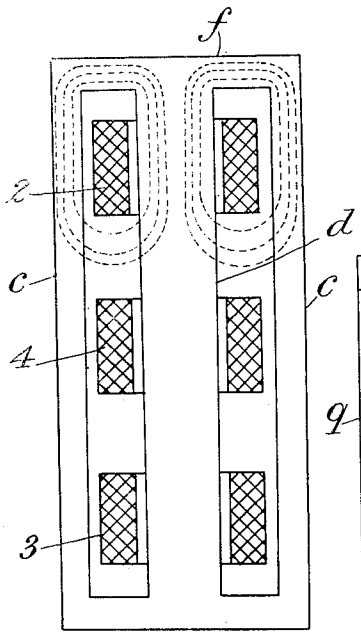

Fig. 1.

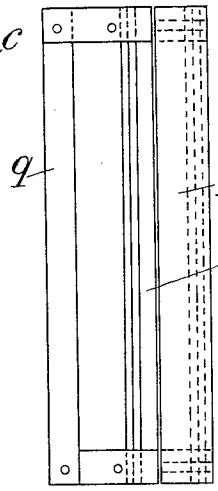

Fig. 5.

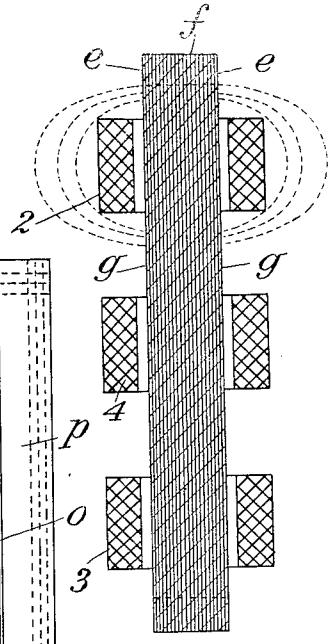

Fig. 3.

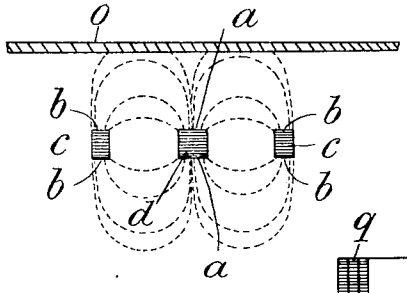

Fig. 2.

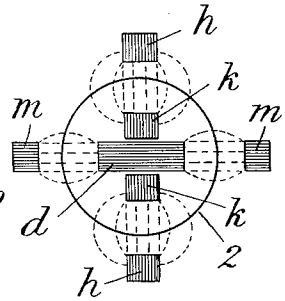

Fig. 4.

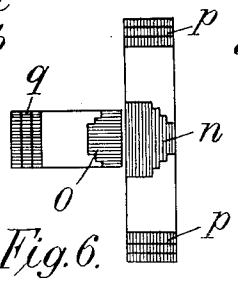

Fig. 6.

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UNITED STATES PATENT OFFICE

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MOVING COIL VOLTAGE REGULATOR

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Application September 27, 1935, Serial No. 42,539
In Great Britain October 31, 1934

1 Claim. (Cl. 171—119)

This invention relates to voltage regulators of the type embodying a pair of fixed coils mutually associated so as to possess considerable leakage reactance and a third coil short circuited on itself and devoid of any movable iron core, which latter coil is capable of being moved into positions adjacent to either of the said first named coils or into positions intermediate thereof.

Voltage regulators in accordance with this invention are applicable to a large number of uses and are particularly valuable in association with systems of voltage regulation such as are described in United States Patent No. 1,901,768.

Referring to the accompanying diagrammatic drawing:—

Figure 1 is a sectional front elevation of an existing form of voltage regulator.

Figure 2 is a sectional plan thereof.

Figure 3 is a central vertical sectional view thereof perpendicular to Figure 1.

Figure 4 is a sectional plan view of one form of voltage regulator embodying the present invention, and

Figures 5 and 6 are side and plan views respectively of the core and side yokes of a modified form of voltage regulator embodying the present invention.

In these regulators as usually constructed hitherto the fixed coils have been assembled respectively at the top and bottom of a magnetic core whilst the moving coil slides up and down the core between the two fixed coils if of sandwich arrangement or over them if of concentric arrangement. In either alternative the short-circuited moving coil acts as a shut-gate to the magnetic flux. A typical example of such a regulator is indicated in Figures 1 to 3 in which 2 and 3 represent the fixed coils and 4 the short-circuited winding devoid of any movable iron core movable axially between the coils 2, 3. The flux passing through, say, the fixed coil 2 is, therefore, compelled to return through the space between the fixed and moving coils as indicated by dotted lines passing across the windows of the core from the centre leg to the side yokes. In addition to passing straight from the centre leg to the side yoke or yokes, a considerable portion of flux fringes and passes from the sides *a*, *a* of the centre leg *d* to the sides *b*, *b* of the side yoke or yokes *c*, *c* as is evident from Figure 2. Since the magnetic core is laminated this fringing flux will enter or leave both the side yoke or yokes and the centre leg at a direction at right angles to the plane of the laminations.

Under these conditions the energy loss in the core is very greatly increased. Moreover, in the case of oil-immersed regulators contained in a steel tank some of the fringing flux will enter the tank wall as indicated at *o* and cause additional energy loss in the tank. Further, some of this flux will also pass from the faces *e*, *e* of the top yoke *f* to the faces *g*, *g* of the centre leg *d* as shown in Figure 3 causing additional energy loss in a similar manner.

The main object of the present invention is to eliminate or reduce these losses.

The invention consists briefly in a voltage regulator of the type indicated having a common core associated with a plurality of side yokes, the planes of the laminations in at least one of said side yokes being inclined preferably at a considerable angle, e. g. 90°, to planes containing the laminations in the other or in another side yoke.

In carrying the invention into effect according to one convenient example as illustrated in Figure 4, I provide a central core whose cross section is in the form of a cross lying within a circle with which are associated two sets *h*, *h* and *m*, *m* of side yokes, the laminations in one set being at right angles to the laminations in the other.

The core is subdivided into three parts, one part *d* comprising laminations associated with and parallel to the laminations in one set of side yokes *m*, *m* whilst the laminations in the other two portions *k*, *k* are associated with and are parallel to the laminations in the other set of side yokes *h*, *h*.

There are thus two sets of laminations at right angles, one set having parts *m*, *m* forming side yokes and further parts *d* forming part of the common core and the other set having parts *h*, *h* forming further side yokes and further common core portions *k*, *k*.

The stationary and moving coils are disposed to encircle the core *d*, *k*, *k* and the side legs associated with the respective side yokes, together with the side yokes proper, are disposed external to the coils.

With this arrangement the common core laminations *k*, *k* approach nearer to the associated side yokes *h*, *h* than do the common core laminations *d* and likewise the common core laminations *d* approach nearer to the associated side yokes *m*, *m* than do the other common core laminations *k*, *k*.

In order that the core may have an approximately circular cross section, the core laminations *d*, *k*, *k* may be suitably graded in width.

In carrying the invention into effect according to a modified arrangement as illustrated in

Figures 5 and 6, I provide a common core composed of two sections of laminations, one section comprising core laminations *n* associated with and parallel to two sets of side yoke laminations *p*, *p* whilst the other core section *o* comprises laminations associated with and parallel to one set of side yoke laminations *q*.

The set of laminations having the parts *p*, *n*, *p* are at right angles to the set of laminations having the parts *o*, *q* but the two core parts *o*, *n* together have an approximately circular cross section so as snugly to accommodate the stationary and moving coils of the regulator.

In this arrangement again the common core laminations *o* approach nearer to the side yoke laminations *q* than do the core laminations *n*, *n* and the bulk of the common core laminations *n* approach nearer to the side yoke laminations *p*, *p* than do the core laminations *o*.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

A voltage regulator comprising, a pair of fixed coils mutually associated so as to possess considerable leakage reactance, a third coil short circuited on itself, movably mounted with respect to said pair of coils, a set of laminations parts of which comprise side yoke laminations and other parts of which comprise common core laminations, a further set of laminations inclined to the first mentioned set, parts of the laminations of said further set comprising further side yoke laminations and other parts of the laminations of said further set comprising further common core laminations, said common core formed by said laminations having a cross section wherein at least some of the laminations of any individual set project from the body of the common core to form salients the entire outer faces of which are positioned away from the body of the core in the direction of the respective side yoke laminations.

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