

Aug. 14, 1928.

1,680,910

E. PFIFFNER

EARTHING CHOKING COIL OR VOLTAGE TRANSFORMER FOR HIGH VOLTAGES

Filed June 9, 1925

2 Sheets-Sheet 1

Fig. 1

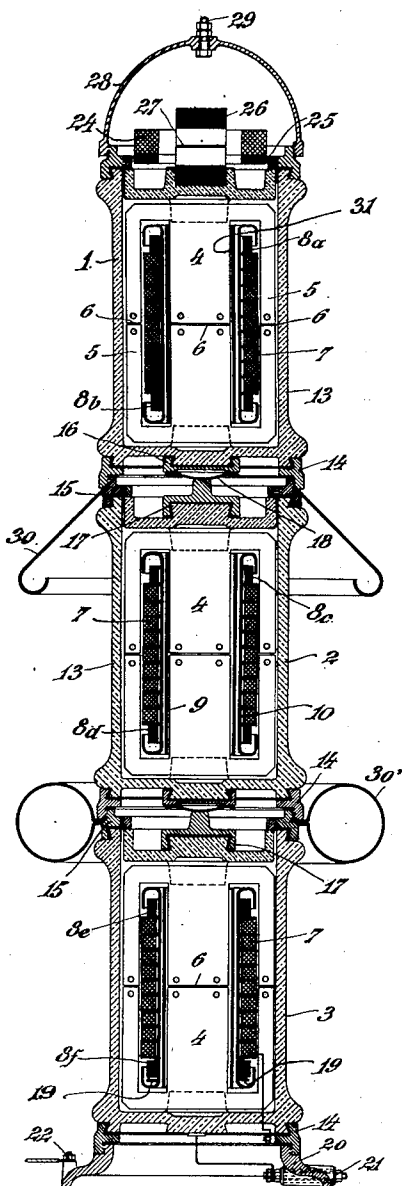
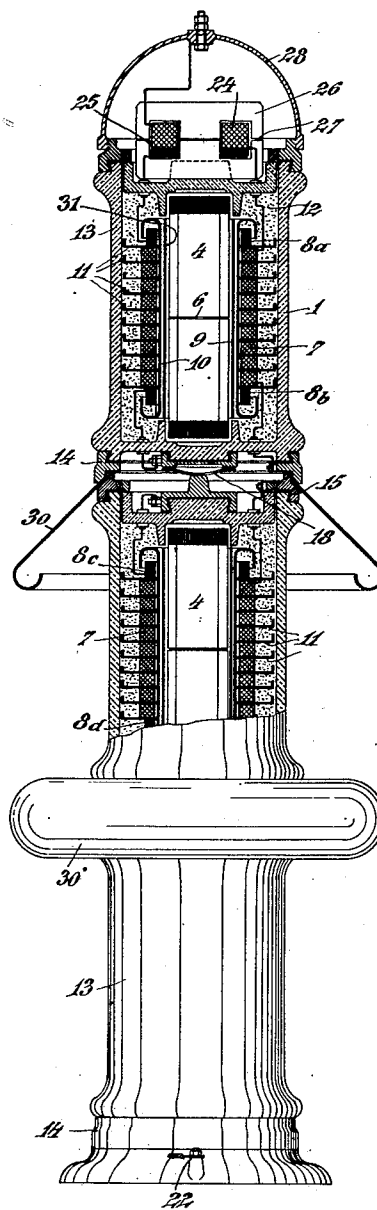


Fig. 2



Inventor
E. Pfiffner
By *Markus Clerk*
Attys.

Aug. 14, 1928.

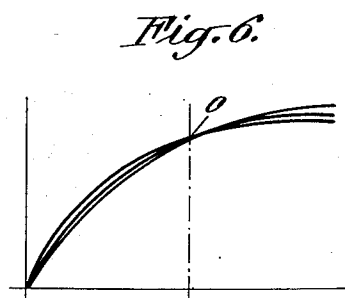
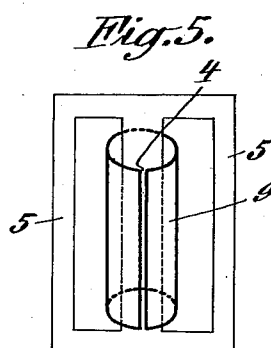
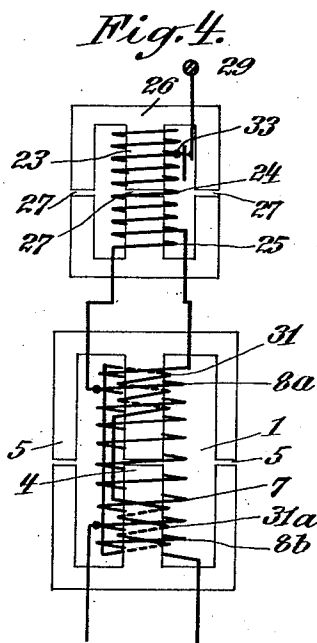
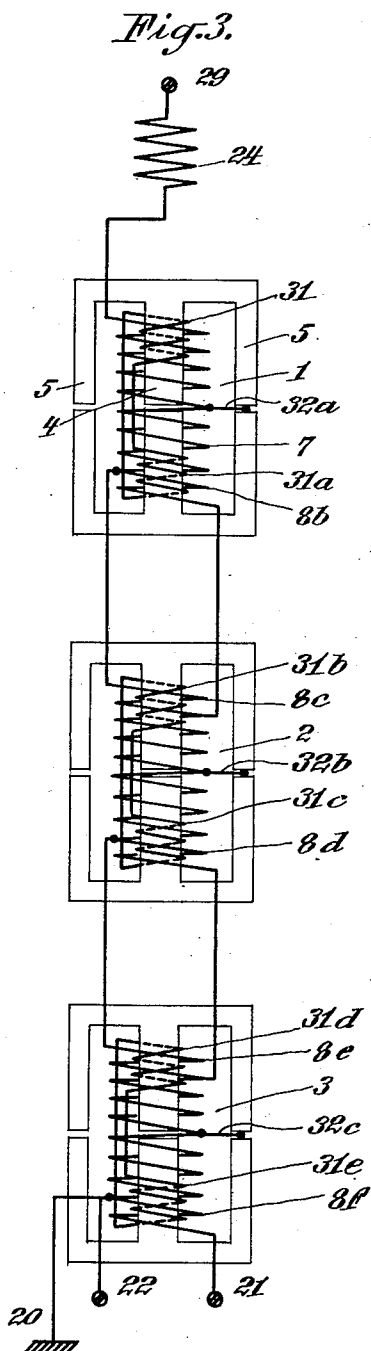
1,680,910

E. PFIFFNER

EARTHING CHOKING COIL OR VOLTAGE TRANSFORMER FOR HIGH VOLTAGES.

Filed June 9, 1925

2 Sheets-Sheet 2



Inventor
E. Pfiffner
By Marko Clark
Attys.

UNITED STATES PATENT OFFICE.

EMIL PFIFFNER, OF FRYBOURG, SWITZERLAND.

EARTHING CHOKING COIL OR VOLTAGE TRANSFORMER FOR HIGH VOLTAGES.

Application filed June 9, 1925. Serial No. 35,997.

This invention relates to improvements in earthing choking coils or voltage transformers for high voltages and essentially consists in the particular construction of a compound or cascade transformer, which renders possible not only the carrying-off of continuous current charges of the network, but also the connection of measuring devices, such as voltmeters and output-meters.

One mode of carrying out the present invention is illustrated by way of example on the accompanying sheets of drawings in which:—

Figs. 1 and 2 show a compound transformer in sectional elevation, the section being taken at 90 degrees with respect to one another.

Figs. 3, 4 and 5 illustrate diagrammatically detail views, and

Fig. 6 shows the magnetization-lines of the individual transformers of which the compound transformer is composed.

Figs. 1 and 2 illustrate a compound or cascade transformer composed of three superposed transformers 1, 2 and 3, each individual transformer being in the shape of a shell transformer provided with cores 4 and yokes 5. The cores 4 as well as the yokes 5 are furnished with adjustable air-gaps 6. The primary windings 7 and the secondary windings 8^a, 8^b, 8^c, 8^d, 8^e and 8^f, connected in series are disposed around the cores 4. Further a compensating winding 9, in the form of a longitudinally slotted copper cylinder, is located round the core, and an insulating sleeve 10 is arranged between the said cylinder and the primary and secondary windings. Copper-sheets 11 are arranged between the coils of the primary winding 7, in order to improve the carrying-off of heat, the copper-sheets extending through the filling material 12 to the inner wall of the porcelain casing 13. The ends of the copper-sheets 11 are turned up, in order to provide a better conduction of heat from the said copper-sheets to the inner wall of the porcelain casing 13. The individual porcelain casings of the compound transformer are connected with each other by means of the armature-rings 14 and 15 cemented to the corresponding porcelain casings and screwed together, the said rings being also employed for electrically connecting the transformers 1, 2 and 2, 3 respectively. A second electric connection is established by means of a plate-spring 18 cooperating with hoods 16 and 17,

which are cemented centrally to the porcelain casings. The secondary winding 8^f of the transformer 3 is employed for feeding the measuring devices. In order to protect this winding against static charges, the same is connected with a grounded metallic coil member 19 and with the cast-iron support 20 of the transformer. A terminal 22 and an insulated terminal 21 are attached to the support 20. A choking coil 23, consisting of the windings 24, 25 and the iron core 26, is connected in front of the entire transformer. The connection for the arrangement is shown in Fig. 4. The winding 25 is a part of the choking coil winding 24, 25 and is connected to the coil 8^a of the next transformer. This connection serves for establishing a certain ratio between the field of the choking coil and the field of the first transformer. Fig. 3 shows an arrangement of the choking coil 24, without the compensating coil. Also this iron core is provided with an adjustable air-gap 27. The choking coil is not embedded in a filling material, but is air insulated and protected by a metallic hood 28, which carries a supply terminal 29. In order to properly distribute the electrostatic field outside the transformer, conducting rain covers 30 or tubular rain covers 30' are clamped between the armature-rings 14 and 15.

For the operation as a voltage transformer it is of importance, that in case of an increase or drop of the primary voltage the terminal voltage of the secondary winding always is varied in proportion with the variation of the primary voltage. According to the present invention this condition is satisfied in that the individual transformers are provided with different magnetization-lines. The degree of saturation in the admission transformer 1 is greater than in the transformer 2, and in the latter greater than in the transformer 3, this being accomplished by varying the cross-sectional areas of the iron in the individual transformers and by providing adjustable air-gaps in the magnetic circuit of these transformers. The number of air-gaps of a transformer depends on the desired kind of characteristic of this transformer. A comparison between the magnetization-lines of the three transformers is illustrated in Fig. 6 of the drawings. At an ordinary working voltage the decrease of voltage in the first transformer is larger than in the last transformer owing to this distribution of field. In case

the primary voltage is increasing the decrease of voltage of this transformer will be more rapid than corresponds to the increase of the primary voltage, in consequence of the smaller saturation of the transformer 3. However owing to the greater primary voltage and the increased charging rate called for by this, the decreases of voltage have also mounted up in consequence of leakage and resistance, and therefore the observation of the correct secondary voltage is rendered possible.

A connection is employed to distribute in the desired manner the primary high voltage to the individual transformers. In the diagrammatic view shown in Fig. 3 two successive transformers 1 and 2, and 2 and 3 respectively are coupled with each other by the coils 8^b, 8^c and 8^a, 8^e respectively. These coils form a part of the beginning and end of the primary winding 7 of each transformer. The connection of these coils 8^b, 8^c, 8^a and 8^e is such, that the voltages induced in the same by the alternating field of the transformers are eliminated if the fields are alike, e. g. of the same strength. In case a difference in the fields arises owing to the dissimilarity of the magnetic resistances, a current passes through the said coils, the said current supplying ampere-turns to re-establish the field-similarity. But these windings alone and the primary winding would result in a considerable leakage. In order to avoid this, a compensating winding is arranged within each individual transformer. In Fig. 3, the reference characters 31, 31^a, 31^b, 31^c, 31^d and 31^e designate these windings of the three transformers. Each compensating winding consists of two coils arranged at the ends of the core. These coils are connected with each other in such a manner, that in case of similarity of the fields at the end of each core no current is passing. A short-circuit current is produced which effects an equalization of field, in case of dissimilarity in the field of a core, which is caused in consequence of leakage between the said windings 31 and the winding 7. As shown in Fig. 5, a longitudinally slotted solid cylinder 9 of copper may be substituted for the winding 31. This cylinder prevents not only the leakage between the primary winding 7 and windings 8, but also the leakage within the primary winding. The copper cylinder, disposed around the core, serves not only as a cover of the core, but also acts as a winding and therefore has to consist of a well conducting material. In case a pulsating magnetic flux passes through the said cylinder, the tensions produced in the cylinder are eliminated only in case the strength of the magnetic field within the cylinder is alike at all places. In case the field within the cylinder is not alike at all

places, for instance by the admission or discharge of the stray lines, a current is formed in the copper cylinder, which compensates these differences in the intensity of field by means of the produced ampere-windings.

In order to produce satisfactory conditions of insulation between the winding and core, each iron core is brought to the medium potential of the corresponding decrease of voltage by means of the connection 32^a, 32^b and 32^c attached to the middle of its primary winding. The end of the primary winding of the last transformer 3 is grounded. In order to avoid the coil 8^f, supplying the measuring instrument, from being charged with dangerous voltages by the static induction of the iron core, this coil is wound upon a conducting coil casing, which is connected with the earth connection of the transformer. In front of the first transformer is conductively mounted a choking coil 24 (Fig. 3), which protects the compound transformer against jumping waves. This choking coil is not embedded in insulating material in order that it can be removed easily in case of defects. The choking coil can be used for correcting the transformation ratio and any inaccuracies of the voltage transformer. For this object the choking coil is provided with adjustable air-gaps in the magnetic circuit and with tapping places 33 (Fig. 4) for attachment to the primary terminal 29. The tension of the transformer can be reduced by providing the choking coil with a larger number of windings. The tension of the transformer and thus also of the measuring instrument can be increased by reducing the number of windings of the choking coil. The correct number of windings is determined at the time of calibrating the transformer by connection to the convenient tapping place of the choking coil winding. The last turns 25 of the choking coil are connected with the first compensation coil 8^a of the first transformer for the purpose of magnetic connection or coupling.

I claim:—

1. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a primary winding on each section and a compensating winding on each section connected in series with said primary winding, said compensating winding of each section being connected with the windings of the adjacent sections.

2. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a primary winding on each section, a compensating winding on each section connected in series with said primary winding, said compensating winding of each section being connected with the windings of

the adjacent sections, and a separate insulating casing enclosing each magnetic circuit.

3. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit of different cross sectional area provided with an air gap, a primary winding on each section and a compensating winding on each section connected in series with said primary winding, said compensating wind of each section being connected with the windings of the adjacent sections.

4. A transformer comprising in combination, a plurality of sections, each section having a magnetic circuit provided with an air gap, a plurality of coils in each section magnetically connecting said magnetic circuits and a slotted metallic cylinder arranged on the core of each magnetic circuit.

5. A transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a plurality of coils in each section magnetically connecting said magnetic circuits, a slotted metallic cylinder arranged on the core of each magnetic circuit, a primary winding on each section and an electric connection between the core of each section and the middle of said primary winding.

6. A transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a plurality of coils in each section magnetically connecting said magnetic circuits, a slotted metallic cylinder arranged on the core of each magnetic circuit, a primary winding on each section, an electric connection between the core of each section and the middle of said winding, a measuring coil on the last magnetic circuit, and a grounded conductive coil-casing on which the said measuring coil is wound.

7. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a primary winding on each section, a compensating winding on each section connected in series with said primary winding, said compensating winding of each section being connected with the windings of the adjacent sections, an electric connection between the core of each section and the

middle of said primary winding, a grounded conductive coil-casing on the last section, a measuring coil wound on said casing, and a choking coil disposed in front of all of the magnetic circuits and arranged in series therewith.

8. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a primary winding on each section, a compensating winding on each section connected in series with said primary winding, said compensating winding of each section being connected with the windings of the adjacent sections, an electric connection between the core of each section and the middle of said primary winding, a grounded conductive coil-casing on the last section, a measuring coil wound on said casing, a choking coil disposed in front of all of the magnetic circuits and arranged in series therewith, and an adjustable air gap provided in the said choking coil.

9. A voltage transformer comprising in combination a plurality of sections, each section having a magnetic circuit provided with an air gap, a primary winding on each section, a compensating winding on each section connected in series with said primary winding, said compensating winding of each section being connected with the windings of the adjacent sections, an electric connection between the core of each section and the middle of said primary winding, a grounded conductive coil-casing on the last section, a measuring coil wound on said casing, a choking coil disposed in front of all of the magnetic circuits and arranged in series therewith, an adjustable air gap provided in the said choking coil, and a plurality of taps on the winding of said choking coil.

10. A transformer comprising in combination a plurality of sections, each section having a magnetic circuit of different iron cross sectional-area with respect to the other magnetic circuits, an air gap provided in each of the said circuits, and a separate insulating casing enclosing each magnetic circuit.

In testimony whereof I affix my signature.

EMIL PFIFFNER.