

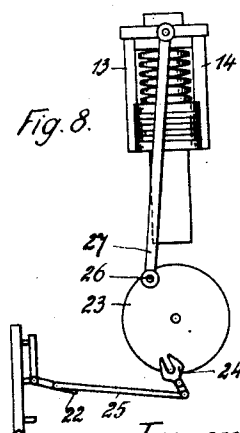
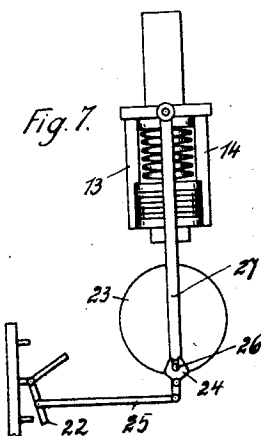
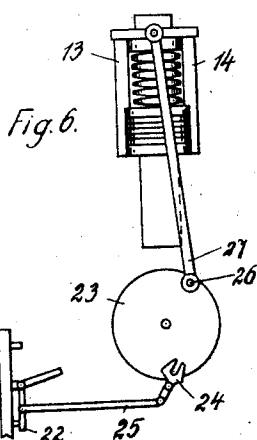
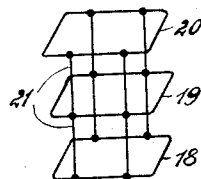
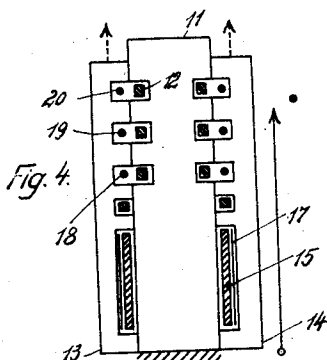
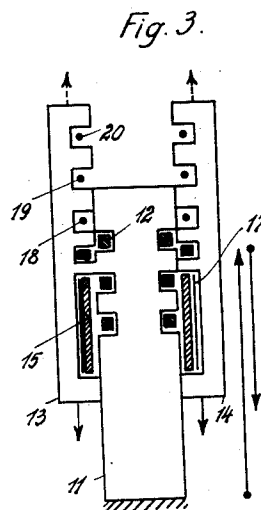
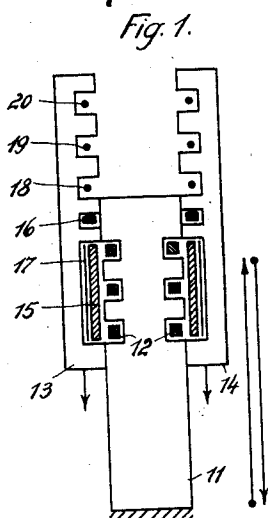
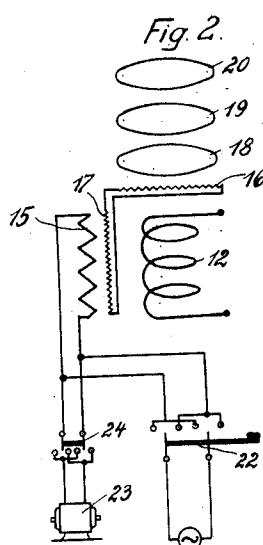
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F. J. FISCHER

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TRANSFORMER

Filed Jan. 18, 1929



Inventor:
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UNITED STATES PATENT OFFICE

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TRANSFORMER

Application filed January 18, 1929, Serial No. 333,236, and in Germany January 20, 1928.

My invention relates to transformers and more especially to voltage-regulating transformers having coils arranged on cores adapted to be displaced with respect to each other, and short-circuit windings. It is an object of my invention to reduce the size of such transformers as hitherto designed. To this end I so arrange the short-circuit windings on an iron core that an iron return path is provided for the flow of lines of force when all or part of the windings cooperate with the secondary coil.

It has already been proposed to provide in transformers of this type two primary coils on an iron core, said primary coils being adapted to be displaced with respect to the secondary winding disposed on a fixed iron core. By means of such transformers the voltage can be regulated from the positive maximum through zero to the negative maximum but owing to the two superimposed primary coils the size of such transformers becomes so large as to be prohibitive as far as the active material, the oil and the oil tanks are concerned.

It has further been proposed to eliminate this drawback by providing only a single primary coil and to suppress the inductive drop of voltage in the final positions by providing freely exposed short-circuit windings at either side of the primary coil. In this arrangement, however, owing to the poor coupling at the usual number of periods, the aim of reducing the drop of voltage is not attained to a sufficient extent when the secondary coil cooperates with the short-circuit windings.

By providing the arrangement according to the present invention the flow of force lines, upon full or partial cooperation of the short-circuit windings, does not occur in air but in iron and, as iron constitutes a good magnetic return path, a good coupling is obtained between the secondary winding and the short-circuit windings and the drop of voltage is reduced substantially to the leakage voltage. On the other hand this involves the drawback that not the double, but only the single range of regulation is available. This drawback is obviated by means of a

known expedient which has already been proposed in transformers with respect to voltage regulation and which consists in changing the polarity of the primary coil so as to generate positive or negative or no additional voltage. It is, however, necessary to effect this change under full load and, moreover, complicated switching means are required when switching from plus to minus. This is due to the fact that with open primary coil a strong magnetic field is induced in the coil by the current flowing in the secondary coil and this field generates a very high voltage in the primary coil, so that it is necessary to change from the plus to the minus position through a short-circuiting position.

By applying this well known expedient to the present invention the regulating range is doubled as will be described more fully hereinafter. The changing-over of the primary winding and the consequent change of polarity of the secondary coil is effected according to this invention in that final position of the movable iron body in which the secondary coil cooperates with the short-circuit windings, the primary coil running idle and being supplied from the system. In this case not a load but only the primary idle current of the transformer is disconnected. High voltage cannot form in the primary coil as the secondary coil is not arranged opposite the primary.

In the drawings affixed to this specification and forming part thereof transformers embodying my invention are illustrated diagrammatically by way of example.

In the drawings—

Fig. 1 shows the transformer in its maximum position,

Fig. 2 is a diagram showing the connections of the coils,

Fig. 3 shows the middle and

Fig. 4 the zero position of the transformer.

Fig. 5 is a diagram of connections for short-circuiting rings.

Figs. 6-8 show a mechanism for controlling the polarity of the primary winding by means of the movable yokes of the transformer.

Referring to the drawings, 11 is the core, 100

12 is the secondary winding disposed in notches of the core, 13, 14 are yokes adapted to be displaced together on the core 11, 15 is the primary coil mounted on the lower ends of the yokes concentrically to the secondary coil 12, 16 is a compensating winding in the central portion of the yokes, 17 is an auxiliary winding cooperating with the compensating winding for controlling the flow of force lines in intermediate positions and 18, 19, 20 are short-circuit windings, which may be disposed in notches in the upper portion of the yokes 13, 14. These short-circuit windings may consist of a great number of closed windings or of short-circuiting rings as shown in Fig. 2. However, as shown in Fig. 5, the rings 18, 19, 20 may also be connected and braced by conductors 21 so as to distribute mechanical and electric loads from one part onto the other parts.

The operation of this transformer is as follows:

In the position illustrated in Fig. 1 the transformer operates at maximum voltage as indicated by the vectors shown on the right. If it is desired to reduce the voltage, the yokes 13, 14 are moved downwardly as indicated by the arrows. Thereby, as the primary winding 15 is displaced relative to the secondary winding 12, the secondary winding is placed within reach of the short-circuit windings 18, 19, 20 and therefore those windings which are within reach of the short-circuit windings become inactive with respect to the ratio and only the two parts of the secondary winding opposite the primary winding are induced as shown in Fig. 3. In consequence thereof the transformer in this position will only yield two-thirds of the voltage. When the yokes 13, 14 are moved still further down, the reduction of voltage will proceed as the secondary winding 12 is shifted out of reach of the induction of the primary 15 and cooperates with the short-circuit windings.

Fig. 4 shows the lower final position of the yokes 13, 14, in which the secondary 12 entirely cooperates with the short-circuit windings, the primary 15 only acting as an idle transformer. In this position and with the object of obtaining the double regulating range, the change of polarity of the primary 15 is effected by means of a throw-over switch 22 whereby the flow of force lines is reversed. If now the yokes 13, 14 are raised again as indicated by the dotted arrows, the flow of the force lines in the secondary 12 is reversed and therefore the direction of the current and voltage therein is reversed also. The secondary 12 will finally return into the upper final position shown in Fig. 1, wherein maximum voltage obtains again, but with the opposite index so that now the double range is obtained from minus maximum through zero to plus maximum. The polarity of the pri-

mary 15 can be changed by means of normal switches, as only the idle currents of the transformer are switched. The switches may be controlled by the yokes 13, 14 by means well known to those skilled in the art, for instance by means of a crank gear shown in Figs. 6-8 comprising a rod 27, one end of which is connected to the yokes 13, 14, the other end being connected to a crank disc 23. A pivotally mounted lever 24 is connected by means of a link 25 to the switch 22. The upper end of the lever 24 is bifurcated and engages the pin 26 connecting the rod 27 with the disc 23 when the yoke occupies its lowest position in Fig. 7. Therefore the switch is switched over if the yoke reaches its lowest position.

If for higher loads the yokes 13, 14 are operated by a motor 23, this motor may be reversed simultaneously with the changing of polarity of the primary 15 by the motor being directly connected to the primary 15 at low voltage. At high voltage it may be supplied from the primary 15 through an intermediate transformer or by placing a separate low voltage coil on the primary 15.

In the case of three-phase current a further reversing switch (not shown) may be coupled with the switch 22, this switch exchanging two phases for reversing the motor. A press-button switch 24 may be provided for independent control of the motor 23.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

In the claims affixed to this specification no selection of any particular modification of the invention is intended to the exclusion of other modifications thereof and the right to subsequently make claim to any modification not covered by these claims is expressly reserved.

I claim:

1. A voltage regulating transformer comprising two iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core and a short-circuit winding arranged on the core carrying said primary winding, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores.

2. A voltage regulating transformer comprising two iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core and a short-circuit winding arranged in notches of the core carrying said primary winding, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores.

3. A voltage regulating transformer comprising two iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core and short-circuit windings arranged on the core carrying said primary winding, mechanical and electric connections between said short-circuit windings, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores.

4. A voltage regulating transformer comprising two iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core, a short-circuit winding arranged on the core carrying said primary winding, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores, and a compensating coil intermediate said short-circuit winding and said primary winding.

5. A voltage regulating transformer comprising iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core, a short-circuit winding arranged on the core carrying said primary winding, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores, and means for changing the polarity of said primary winding.

6. A voltage regulating transformer comprising two iron cores displaceable relative to each other, a primary winding on one, a secondary winding on the other core and a short-circuit winding arranged on the core carrying said primary winding, the cores and the windings being arranged in such manner that the flow of force lines produced by said windings occurs substantially within said iron cores, and means under the control of said iron cores for changing the polarity of said primary winding.

In testimony whereof I affix my signature.
FRANZ JOSEPH FISCHER.