

June 10, 1941.

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2,245,266

VARIABLE TRANSFORMER

Filed Sept. 13, 1938

2 Sheets-Sheet 1

Fig. 1.

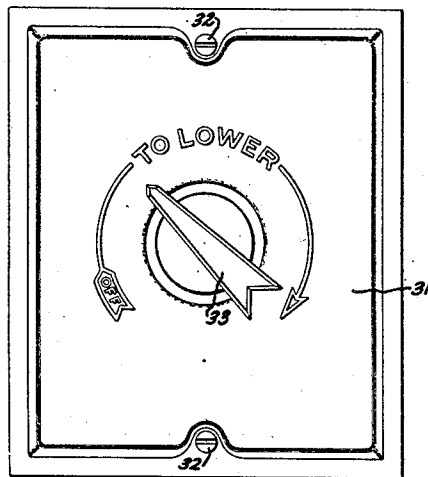


Fig. 2.

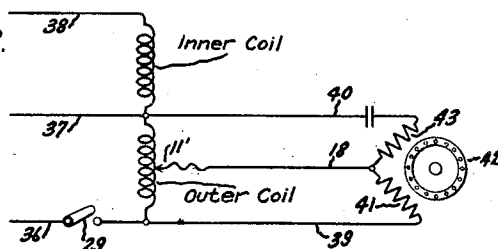
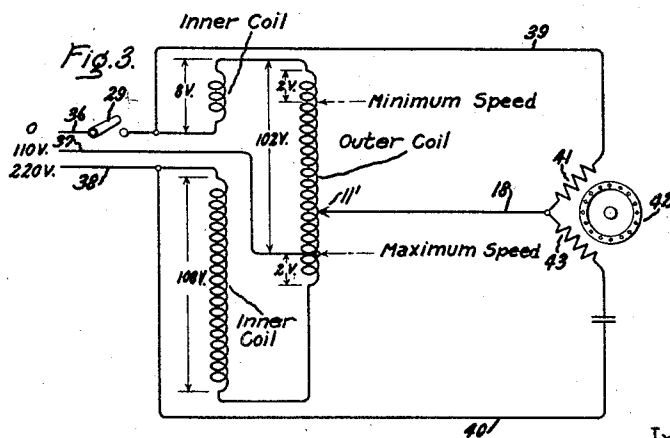


Fig. 3.



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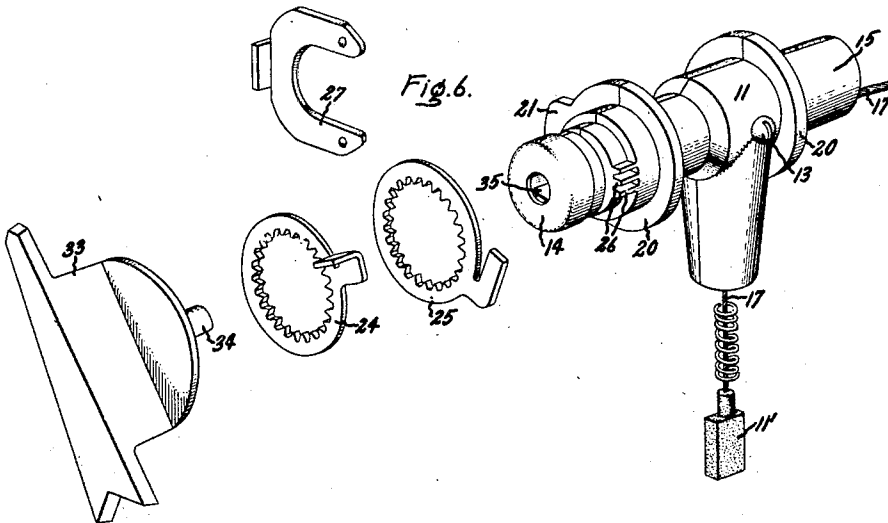
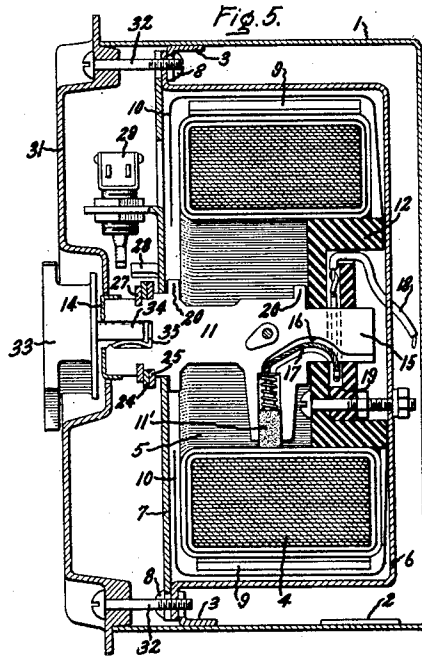
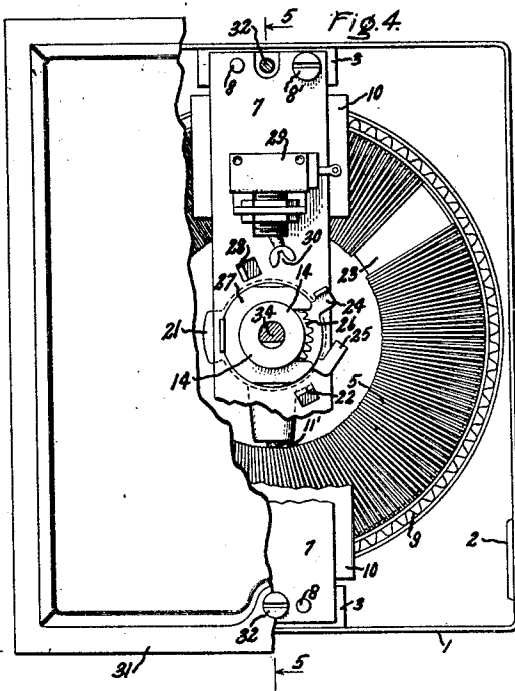
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VARIABLE TRANSFORMER

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,245,266

VARIABLE TRANSFORMER

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Application September 13, 1938, Serial No. 229,726

12 Claims. (Cl. 171-119)

This invention relates to variable transformers and more particularly to improvements in the construction of variable transformers of the type in which a movable brush makes contact with the transformer winding.

By the term variable transformer, we mean either a conventional transformer, or an autotransformer or a reactor whose effective number of winding turns is variable. A reactor is properly included because structurally it is like a transformer, the primary difference being merely one of function or use.

In a well-known form of a variable transformer of this type the core is toroidal in shape and the brush is rotated about the axis of the core. In this manner a simple and compact construction is provided.

In accordance with this invention the construction is improved and simplified in a number of particulars.

An object of the invention is to provide a new and improved variable transformer.

Another object of the invention is to provide a variable transformer, of the type in which a brush slides on the inner surface of a toroidal winding, with means for causing the conductors of said winding to lie substantially in a cylindrical surface along the brush path.

Another object of the invention is to provide a new and improved arrangement for supporting and confining the brush pigtail.

A further object of the invention is to provide novel and simple means for adjusting the limits of brush travel.

An additional object of the invention is to provide a new and improved way of placing a two-layer variable autotransformer winding on a toroidal core.

The invention will be better understood from the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

In the drawings, in which similar reference characters designate the same elements throughout the several views, Fig. 1 is a front view of the variable transformer with the cover in place, Fig. 2 is a circuit diagram of the transformer connected as a speed controller for the split-phase motor, Fig. 3 is a modification of Fig. 2 in which the transformer winding is placed on the core in a novel manner so as to secure rated voltage on both motor windings, Fig. 4 is a view similar to Fig. 1 with part of the cover and supporting means broken away, Fig. 5 is a sectional view along the line 5-5 of Fig. 4, and Fig. 6 is a de-

tailed so-called exploded view of the adjustable means for limiting the range of brush travel.

Referring now to the drawings and more particularly to Figs. 4 and 5, the transformer is mounted in a casing 1. This casing is in the form of a conduit or outlet box and is provided with knockouts 2 through which connections can be made to the transformer as desired. Brackets 3 fastened to the inside of the casing in any suitable manner such as by welding or soldering, provide means for fastening the transformer in the casing. The transformer consists essentially of a toroidal core 4 which is preferably, although not necessarily, of wound instead of disc construction and a winding 5 thereon. Winding 5 is shown, by way of example, as consisting of two layers. This coil and core assembly is clamped between a supporting strap 6 and a front strip 7 by means of screws 8. Screen 8', passing through clearance holes in members 6 and 7, are threaded into brackets 3 for holding the assembly in the casing. Suitable insulation 9 and 10 is placed between the winding 5 and the supporting members 6 and 7. For making contact with the inner surface of the winding so as to vary the transformer ratio is a brush or slidable contact 11'.

It has been found that it is difficult to place the winding 5 on the core in such a way that all of the conductors will lie evenly and this difficulty is accentuated when the winding is clamped in a support, as the clamping action tends to buckle some of the turns and thus produce an uneven arrangement of the turns. This makes it difficult for the brush to slide evenly in the winding.

In order to overcome this difficulty there is provided what is referred to as a wire retainer 12. This wire retainer is preferably made of insulated material, such for example as the synthetic resin known as "Bakelite" and is shown in the form of a circular cup-shape member. This wire retainer is pushed through the opening in the toroidal winding from the front to the back, thereby smoothing out the inner surface of the winding and forcing all of the inner conductors of the winding to lie substantially in a cylindrical plane.

The brush 11' is carried by a brushholder 11. This holder is split longitudinally into complementary halves in order to facilitate its internal construction. It may be made of the same insulating material as the wire retainer 12. The two halves are held together by a bolt 13 passing through the center thereof and by a circular metal cap 14 on one end thereof.

The wire retainer 12 is provided with an opening which is concentric with the axis of the toroidal core and winding and this opening acts as a bearing support for the shank 15 of the brushholder.

The brushholder is provided with an internal passageway 16 for conducting the brush pigtail 17 to the back of the wire retainer 12. After it has passed through the wire retainer the pigtail is wrapped one or more times around the shank 15 of the brushholder, so as to provide enough slack to permit rotation of the brushholder. Its end is then fastened to a lead 18, the end of which is clamped between a pigtail retainer 19 and the wire retainer 12.

The other bearing support for the brushholder is provided for by an opening in the strip 7 and the brushholder is prevented from axial movement by suitable flanges 20 formed thereon.

The outer flange 20 is provided with a lug or projection 21 which cooperates with a stop 22 formed by pressing inwardly a finger 22 formed out of the strip 7. This construction automatically limits the maximum angle through which the brush can be rotated and prevents the brush from falling into a space 23 between the ends of the outer layer of the winding 5.

Often it is desirable, however, to prevent the brush from being rotated through this maximum angle, so as for example to prevent the application of overvoltage to a device connected to the output of the transformer. This limitation of the brush travel to any desired portion of its maximum range of travel is secured by a novel construction consisting of a pair of index plates 24 and 25. These plates have circular openings provided with teeth which engage a set of teeth 26 of the brushholder. Thus, the index plates may be rotated through any desired relative angle and then fitted onto the brushholder into engagement with the teeth 26 which will then lock them in this relative angular relationship. They are retained in position by means of a split or prong-shaped spring member 27 which fits into a groove in the brushholder. Projections on the plates 24 and 25 cooperate with an upset stop member 28 formed in the strip 7.

The circuit of the transformer is controlled by a switch 29 shown, by way of example, as a conventional toggle-operated snap switch. Its operating arm is provided with a notch 30 which is entered by the projection on the index plate 24 so that when the brush is moved counterclockwise to one of its previously set limits the switch 29 will automatically be opened and as soon as the brushholder is rotated in a clockwise direction so as to move the projection on plate 24 away from stop 28 the switch 29 will be closed. When the brushholder is rotated in a clockwise direction, the adjustable index plate 25 cooperates with stop 28 to limit the range of the brushholder in this direction.

The front of the casing 1 is closed by a suitable cover 31 fastened thereto by means of screws 32 threaded into the brackets 3. Cover plate 31 is provided with a dished-in central portion having an opening surrounding the metal cap 14. Fitted into this dished-in portion is an operating handle 33 having a flat-sided extension or shaft 34 which enters the end of the brushholder and which is frictionally retained therein by means of a spring member 35 which is pressed between the side of the end opening of the brushholder and the flat portion of the extension 34 of the handle. In this manner the handle may readily be re-

moved by merely pulling it out away from the casing.

In Fig. 2 the transformer is shown as being provided with three input leads 36, 37 and 38 and with three output leads 39, 18 and 40. Input leads 36 and 37 are adapted to be connected to a standard alternating current circuit of a given voltage and leads 36 and 38 are adapted to be connected to a similar circuit of double this voltage. The main winding 41 of a split phase motor 42 is connected between one of the output conductors 39 and the brush lead 18, while a capacitor winding 43 for the motor is connected between the brush lead 18 and output terminal 40. By sliding the brush 11' along the outer coil of the winding 5 the relative voltages of the main and start windings of the motor will be varied in order to vary the motor speed over a wide range.

In Fig. 3 the fundamental circuit is the same as in Fig. 2 except that output lead 40 has been connected to input lead 38 instead of to input lead 37. The motor 42 will be assumed, for purposes of illustration, to be a standard motor having a rated voltage of 110 volts. The purpose of the modification shown in Fig. 3 is to insure that full 110 volts is applied to both motor windings when it is started and whenever maximum speed is desirable. Suitable supply circuits for connection between input conductors 36 and 37 on the one hand and input conductors 36 and 38 on the other hand will be 110 volt and 220 volt circuits, respectively.

As is shown by way of example in Fig. 3 the inner coil or layer of the winding comprises a 108 volt section and a separate 8 volt section between one terminal of each of which is connected to the outer layer, which is adapted to operate at 104 volts, thus making up the total 220 volts. The reason that the voltage of the inner layer is higher than the voltage of the outer layer is because it is necessary to provide the space 23 between the ends of the outer layer so as to prevent any possibility of the brush 11' short circuiting the entire outer layer and also in order to provide proper insulation between the ends of the outer layer. This also means that only a portion of the outer layer can be used for securing adjustable voltage because the brush must be limited in its motion at the ends of the outer layer adjacent the space 23 so as to prevent the brush 11' from falling into this space. If that happened it would be difficult to get the brush on the winding again. Thus, as indicated by way of example in Fig. 3, there are 2 volt sections on each end of the outer coil onto which the brush 11' is not allowed to move. The electrical midpoint of the winding is connected to the input lead 37 and corresponds to the point on the winding where the brush 11' is limited in its motion in the maximum voltage direction. If the index plates 24 and 25 are set so that their maximum limits correspond to the maximum limits set by the projection 21 and stop 22 the switch 29 will automatically be opened when the brush 11' is placed in this maximum speed position and will automatically be closed as soon as the brush is moved away from this position toward the minimum speed position. As will be seen from Fig. 3, the voltage applied to both windings 41 and 43 of the motor will be 110 volts when the brush is in the maximum speed position and that as the brush is moved toward the minimum speed position the voltage of the main winding is decreased and the voltage of the start winding is increased. With this arrangement the motor will always be

started at maximum voltage and will thus always develop maximum starting torque.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States, is:

1. A variable transformer comprising, in combination, a toroidal core of magnetic material having a cylindrical inner surface, a winding on said core, a relatively thin circular wire retaining member of insulating material pressed into the opening of said core for forcing the individual conductors forming the inner surface of said winding to lie evenly in a substantially cylindrical surface adjacent the inner side of said wire retaining member, a brush for contacting the inner surface of said winding adjacent the inner side of said wire retaining member, a rotatable holder for said brush, and an opening in the center of said circular wire retainer forming a bearing support for said brushholder.
2. A variable transformer comprising, in combination, a toroidal core of magnetic material having a cylindrical inner surface, a winding on said core, a relatively thin circular wire retaining member of insulating material pressed into the opening of said core for forcing the individual conductors forming the inner surface of said winding to lie evenly in a substantially cylindrical unobstructed surface, a movable brush for engaging said unobstructed surface, a casing for said core and winding, and means for clamping said winding and core to the inner walls of said casing independently of said wire retaining member.
3. A variable transformer comprising, in combination, a toroidal core of magnetic material, a winding on said core, a circular wire retaining member of insulating material pressed into the opening of said core for forcing the individual conductors forming the inner surface of said winding to lie evenly in a substantially cylindrical surface, a brush for contacting the inner surface of said winding, a rotatable holder for said brush, an opening in the center of said circular wire retainer forming a bearing support for said brushholder, a passageway in said brushholder between said brush and the opposite side of said wire retainer, and a pigtail connection for said brush inserted in said passageway.
4. A variable transformer comprising, in combination, a toroidal core of magnetic material, a winding on said core, a circular wire retaining member of insulating material pressed into the opening of said core for forcing the individual conductors forming the inner surface of said winding to lie evenly in a substantially cylindrical surface, a brush for contacting the inner surface of said winding, a rotatable holder for said brush, an opening in the center of said circular wire retainer forming a bearing support for said brushholder, a passageway in said brushholder between said brush and the opposite side of said wire retainer, a pigtail connection for said brush inserted in said passageway, said pigtail being wound around said brushholder, and a pigtail retaining member fastened to said wire retainer and forming a space therebetween for the coil formed by said pigtail.

5. In a variable transformer of the type comprising a winding and a movable brush slidable across said winding for varying the transformer ratio, the combination of a rotatable holder for said brush, said holder having a section provided with at least one outwardly extending projection, a pair of index members provided with openings having at least one inwardly extending recess for receiving said projection, extensions on said members, and a stop arranged in the path of rotation of said extensions for limiting the rotation of said brush to a predetermined portion of a complete turn.

6. In a variable transformer of the type comprising a winding and a movable brush slidable across said winding for varying the transformer ratio, the combination of a movable holder for said brush, means including an element adjustably positioned on said brushholder for limiting the motion of said brushholder in one direction to any particular point on said winding, means including a separate element independently adjustably positioned on said brushholder for limiting the motion of said holder in the opposite direction to any other particular point on said winding, and a common locking mechanism on said brushholder for both of said adjustable elements.

7. In a variable transformer of the type comprising a winding and a movable brush slidable across said winding for varying the transformer ratio, the combination of a rotatable holder for said brush, said holder having a circular section provided with a plurality of outwardly extending teeth, a pair of index plates provided with circular openings having a plurality of inwardly extending teeth for receiving the teeth on said holder, extensions on said index plates, a stop mounted in the path of rotation of said extensions for limiting the rotation of said brushholder to any predetermined portion of a complete turn thereof which is determined by the relative settings of said index plates, and means for maintaining engagement between the teeth on said index plates and the teeth on said circular section of said brushholder.

8. A variable transformer comprising, in combination, a winding, a movable brush slidable across said winding for varying the transformer ratio, a movable holder for said brush, adjustable means for limiting the motion of said brushholder in one direction to any particular point on said winding, separate independently adjustable means for limiting the motion of said holder in the opposite direction to any other particular point on said winding, and a switch in circuit with said transformer arranged to be actuated by one of said adjustable means in response to its rotation by said brushholder.

9. In a variable transformer, a toroidal core, a two-layer serially-connected autotransformer winding on said core, said winding having three input leads connected respectively to the terminals of said winding and to the electrical midpoint thereof, a brush slidable across the outer layer of said windings, said winding having three output leads connected respectively to the terminals of said winding and to said brush, the ends of said outer layer being separated by a space sufficient to prevent short circuiting of said outer layer by said brush, and means for limiting the motion of said brush toward said space so as to prevent said brush from dropping off said outer layer into said space, one of the limiting positions

of said brush corresponding substantially to the electrical midpoint of said winding.

10. In combination, an autotransformer having a two-layer winding, the electrical terminals of said winding being in the inner layer thereof, the electrical midpoint of said winding being in said outer layer, and a contact movable across the outer layer of said winding and having a range of motion which includes contact with said electrical midpoint.

11. In combination, a transformer provided with a toroidal core, a two-layer autotransformer winding on said core, the outer layer of said winding having a space between its extremities, the electrical terminals of said winding being in the inner layer thereof, the electrical midpoint of said winding being in the outer layer thereof adjacent to but not at the edge of said space between the ends of said outer layer, and a contact

movable across the outer layer of said winding and having a range of motion which includes contact with said electrical midpoint.

12. In combination, a single phase autotransformer having a pair of output terminals connected to the extremities of its winding, a contact movable on said winding and having a range of positions which includes contact with the electrical midpoint of said winding, an input circuit for said transformer, a switch connected in said input circuit, and means responsive to the position of said movable contact for opening said switch when said contact is in engagement with substantially the electrical midpoint of said winding and for closing said switch when said contact is in any other position.

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