Dec. 22, 1959 O. H. BEYMER 2,918,639

SPACER FOR ELECTRICAL WINDINGS

Filed May 15, 1957

Fig. 1.

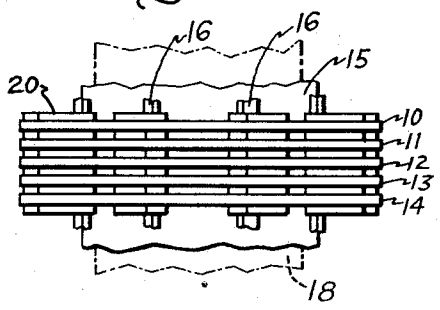


Fig. 4.

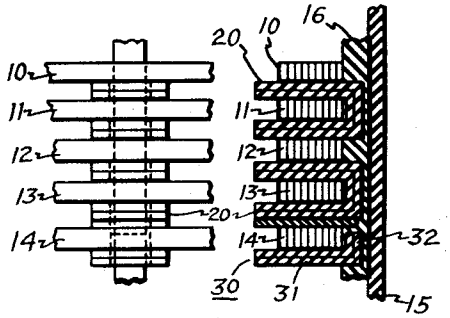


Fig. 5.

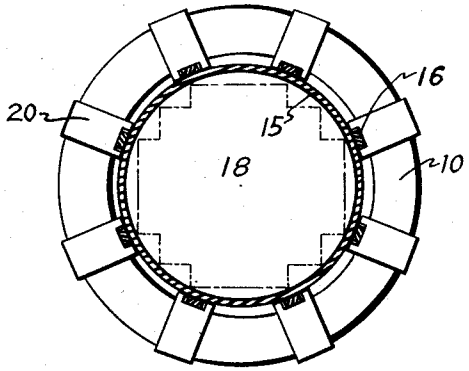


Fig. 2.

Fig. 6.

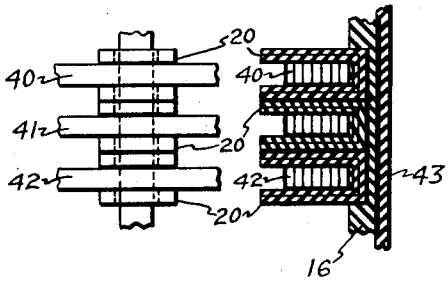


Fig. 7.

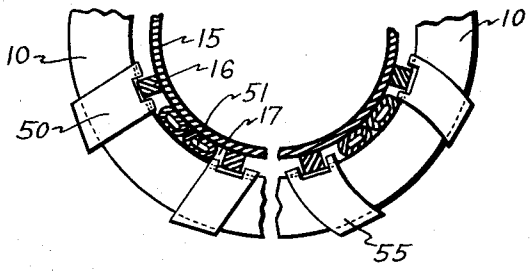


Fig. 8.

Fig. 9.

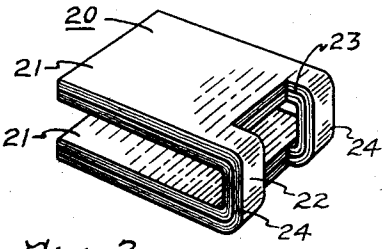


Fig. 3.

Inventor
Oliver H. Beymer,
by Gilbert P. Tarleton
His Attorney.

United States Patent Office 2,918,639 Patented Dec. 22, 1959

2,918,639

SPACER FOR ELECTRICAL WINDINGS

Oliver H. Beymer, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application May 15, 1957, Serial No. 659,261

5 Claims. (Cl. 336—185)

This invention relates to a stationary electrical induction apparatus, and more in particular to an improved spacing arrangement for axially spacing disk-shaped coils of transformers and the like.

In one form of the transformer, the windings are comprised of a plurality of axially displaced disk-shaped coils, the coils generally being serially connected. Each of the disk-shaped coils comprises one or more conductor turns. The coils surround a cylindrical winding member of insulating material, and elongated axially extending spacing members separate the coils from the winding cylinder to provide cooling ducts. The coils are axially displaced in order to provide for proper cooling as well as to insure sufficient insulation therebetween, and in order to maintain the separation of the coils against mechanical displacement or displacement caused by electromagnetic forces in the transformer, it is customary to insert radially extending spacers between the coils.

In the past, various means have been employed for axially spacing the coils. In one conventional spacing arrangement, the axially extending spacing members have a generally T-shaped cross section with the widest portion of the spacing member being away from the winding cylinder. Flat generally rectangular insulating spacers are provided keyed to the T-shaped axially extending spacing member, or tie strip, the flat spacers, otherwise referred to as key spacers, having recesses in one end thereof that match the cross section of the tie strip.

The key spacers are only held in position by small projections engaging the tie strip, and these projections may become broken due to excessive "pounding" of the spacers that may arise, for example, from "arc-back" in rectifier transformers, or from short circuiting of the electrodes connected to arc furnace transformers. The assembly of the key spacers is also time-consuming, since each spacer must be slid along a tie strip from one end thereof to its final position in the winding.

In another spacing arrangement, the axial spacers are comprised of U-shaped members having legs extending between the coils and apexes extending around the radially inner edges of the coils. These spacers are axially aligned so that the legs of adjacent spacers contact each other, the aligned groups of spacers extending axially of the winding between the tie strips. While this type of spacer is more economical than the key spacer, it need not be slide along a tie strip, and is completely locked from radial movement, but it is not keyed in alignment when stacked, and may therefore slide out of the spacer row under pounding conditions, and drift around the inside periphery of the coil.

It is therefore an object of this invention to provide an improved means for axially spacing disk-spaced coils of an electrical winding.

It is also an object to provide spacing means for axially spacing disk-shaped coils of an electrical winding, the spacing means being easily assembled in the

winding during fabrication thereof, and being firmly locked against radial and circumferential displacement.

Briefly stated, according to one aspect of my invention, I provide a winding for an electrical induction apparatus such as a transformer or reactor. The winding is comprised of a plurality of axially aligned disk-shaped coils disposed on a winding cylinder. A plurality of elongated axially extending spacing members space the coils from the cylinder to provide the cooling ducts therebetween. Means are provided for axially spacing the coils, the axial spacing means comprising U-shaped members of insulating material, such as rolled pressboard. The U-shaped members have leg portions extending radially between the coils and apex portions extending around the inner radial edges of the coils. The apexes of the U-shaped members are notched and the axially extending spacing members extend through the notches to prevent circumferential displacement of the U-shaped members.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is a side elevational view of a portion of an electrical winding embodying the spacing arrangement of my invention,

Fig. 2 is a top view of the winding of Fig. 1,

Fig. 3 is a perspective view of a notched U-shaped spacer according to my invention,

Fig. 4 is an enlarged view of a portion of the winding of Fig. 1,

Fig. 5 is a cross-sectional view of the portion of the winding of Fig. 4,

Fig. 6 is an enlarged view of a modification of the arrangement of Fig. 4,

Fig. 7 is a cross-sectional view of the portion of the winding illustrated in Fig. 6,

Fig. 8 is an end view of a portion of a winding and illustrating a modification of the notched U-shaped spacer of my invention, and

Fig. 9 is an end view of a portion of electrical winding and illustrating another modification of the notched U-shaped spacer of my invention.

Referring now to the drawings and more in particular to Fig. 1, therein is shown an electrical winding comprising a plurality of disk-shaped coils **10**, **11**, **12**, **13** and **14**. The coils are axially aligned and surround an insulating cylinder **15**. A plurality of axially extending elongated spacing members **16** are provided on the outer circumference of the winding cylinder **15** to space the coils from the cylinder and provide a cooling duct therebetween. The spacing members **16** are preferably equally spaced circumferentially on the cylinder **15**. The winding cylinder **15** surrounds a magnetic core **18** according to the conventional practice.

The coils **10**, **11**, **12**, **13** and **14** are axially spaced apart by insulating spacing members **20**. As illustrated in Fig. 3, the separator elements or spacing members **20** are comprised of a U-shaped member of insulating material having flat rectangular leg portions **21** joined by an apex or arms portion **22**. The apex portion **22** of U-shaped member **20** is provided with a notch **23** extending completely through the insulation and leaving only edge portions or arms **24** bridging the shorter sides of leg portions **21**. The U-shaped member **20** may be formed of a plurality of layers of insulating material, such as pressboard, molded to a U-shape, the notch **23** being formed by any conventional manner such as punching before forming the member into a U-shape or saw-

ing after the member has been formed into a U-shape.

Referring now to Figs. 4 and 5 which illustrate the spacer of Fig. 3 as it may be employed in a continuously wound winding, the U-shaped members **20** are assembled on alternate coils **11** and **13** with their leg portions **21** extending radially between the adjacent coils and their apex portions **22** extending around the inner radial edges of the coils **11** and **13**. The U-shaped members **20** are axially aligned, and the axially extending spacing members **16** extend through the notches **23** of the U-shaped members **20**.

As illustrated in Figs. 4 and 5, the coil **14** is an end coil of the winding and an L-shaped insulating member **30** is provided having one portion extending along the side of the coil **14** away from the other coils, and another arm **32** extending between the coil **14** and the cylinder **15**. The L-shaped member **30** is notched in the same manner as the U-shaped members **20**.

Referring now to Figs. 6 and 7, therein is illustrated a modification of the arrangements of Figs. 4 and 5, the modification of Figs. 6 and 7 being especially adapted for use on a winding having preformed disk-shaped coils. In this arrangement, the U-shaped members **20** surround each of the coils **40**, **41** and **42** of the winding on the insulating stacking cylinder **43**, so that the leg portions of the U-shaped members surrounding adjacent coils are in contacting relationship.

Referring now to Fig. 8, therein is illustrated a modified form **50** of U-shaped spacer having diamond-shaped legs. The notches of the spacers **50** engage axially extending spacers **16** disposed on opposite sides of a duct **17** through which one or more leads **51** extend. The diamond-shaped legs of the spacers **50** are disposed so that the outer circumferential spacing of their edges is substantially the same as their inner circumferential spacing. This arrangement, as more fully disclosed in U.S. Letters Patent 2,467,804, which issued on my application and is assigned to the assignee of the present invention, provides increased support for the radially outer edges of the coils when it is necessary to provide room for the accommodation of leads in the duct **17**.

In a variation of the arrangement of Fig. 9, the legs of the U-shaped spacers **55** are curved instead of diamond-shaped, and may thus be readily formed from arcuate shaped sections of insulating material. This shape may be more easily formed than the three sided insulation section necessary to form the diamond legged U-shaped member **50** of Fig. 8.

In winding a continuously wound coil (as illustrated in Figs. 4 and 5) employing the U-shaped spacer of Fig. 3, the apexes **22** of the spacers **20** are positioned around the radially inner conductor of the upwound coils (such as coils **11** and **13**) by a single outward radial movement thereof with respect to said coils, as the conductor is wound on the axially extending spacers **16**. The spacers **20** are positioned so that their notches **23** engage the axially extending spacers **16**. The remainder of the conductor turns of the upwound coils are then wound between the leg portions of the U-shaped spacers. No U-shaped spacers are provided on the down-wound coils, such as coils **12** and **14**, since these coils are upset after they are wound. On end coils, such as coil **14**, an L-shaped insulation member **30** may be employed, one arm **32** of the member **30** being notched and positioned around the radially inner edge of the coil **14** and engaging the axially extending spacing member **16**.

When employing the U-shaped member **20** on a winding having preformed coils, such as the winding of Figs. **6** and **7**, the U-shaped members are positioned around the coils before they are slid over the stacking cylinder **43**, so that when the coils are placed over the end of the stacking cylinder the notches **23** engage the axially extending spacing members **16**.

It will be understood, of course, that, while the forms of my invention herein shown and described constitute preferred embodiments of the invention it is not intended herein to illustrate all of the possible equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes may be made without departing from the spirit or scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes as fall within the true spirit and scope of the invention.

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

1. A winding for stationary electrical induction apparatus comprising an insulating winding cylinder, a plurality of axially extending elongated spacing members circumferentially spaced apart disposed on the outer surface of said cylinder, a plurality of axially aligned disk-shaped coils of predetermined thickness surrounding said cylinder and disposed in contacting relationship with said spacing members, said spacing members radially separating said coils from said cylinder, and means for axially separating said coils comprising a plurality of U-shaped members, each of said U-shaped members having substantially parallel legs and a bight portion integrally connecting said legs, said legs being spaced apart by said bight portion a distance substantially equal to the thickness of said coils, each of said U-shaped members having a notch formed in the bight portion thereof, said notch being defined by inner sides of said bight portion that face each other, said sides being straight and parallel to each other throughout their entire extent, so that said elongated spacing members are radially receivable therein, the U-shaped members being placed over said coils in circumferentially spaced relationship with the legs thereof in contacting relationship with said coils, and the bight portions of said U-shaped members being disposed around the inner edges of said coils to prevent movement of said U-shaped members outwardly radially of said coils, said axially extending spacing members being confined within the notches on said U-shaped members to prevent circumferential displacement of said U-shaped members, whereby said U-shaped members are easily installable over said coils by a single outward radial movement thereof with respect to said coils, yet said U-shaped members are substantially immovably locked in said apparatus after insertion of said axially extending spacing members into said notches.

2. The winding of claim 1 in which the U-shaped members are in axially aligned groups equally spaced circumferentially about said winding, and the U-shaped members in said groups surround alternate coils.

3. The winding of claim 1 in which the U-shaped members are in axially aligned groups equally spaced circumferentially about said winding, and the U-shaped members in each group surround adjacent coils so that the leg portions of adjacent U-shaped members are in contacting relationship.

4. The winding of claim 1 in which the U-shaped members are in axially aligned groups spaced about the circumference of said winding, the inner and outer circumferential spacing between the U-shaped members of a pair of adjacent said groups being substantially the same.

5. In a stationary electrical induction apparatus of the type having a plurality of disk-shaped coils of predetermined thickness axially disposed on an insulating winding cylinder and spaced from said cylinder by a plurality of axially extending spacing means, the improvement in means for separating the disk-shaped coils comprising a separator element of generally rectangular outer configuration formed from flat insulating material, said separator element being U-shaped and having a pair of parallel legs integrally joined by a bight portion, said legs being spaced apart by said bight portion a distance approximately equal to the thickness of said disk-shaped

coils, said bight portion consisting of a pair of laterally spaced arms bridging the space between said legs, each of said arms having straight, smooth, parallel inner surfaces that face each other so as to define a notch with sides parallel to the outer configuration of said U-shaped member, said notch being dimensioned so that said axially extending spacing means is radially receivable therein, whereby said separator element is installable over a disk-shaped coil by a single outward radial movement thereof with respect to said coil, and said separator element is

locked into substantially immovable relationship to said apparatus by radially inserting said axially extending spacing means into the parallel surfaced notch in the bight portion of the separator element.

References Cited in the file of this patent

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1,310,063	Cummings	July 15, 1919
2,467,804	Beymer	Apr. 19, 1949

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,918,639 December 22, 1959

Oliver H. Beymer

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 61, for "slide" read -- slid --; column 2, line 63, for "arms" read -- bight --.

Signed and sealed this 24th day of May 1960.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

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