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MEANS FOR SPACING DISK COILS

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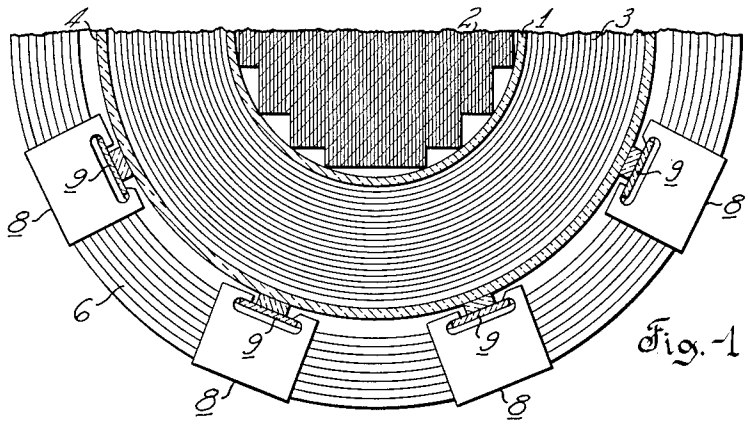


Fig. 1

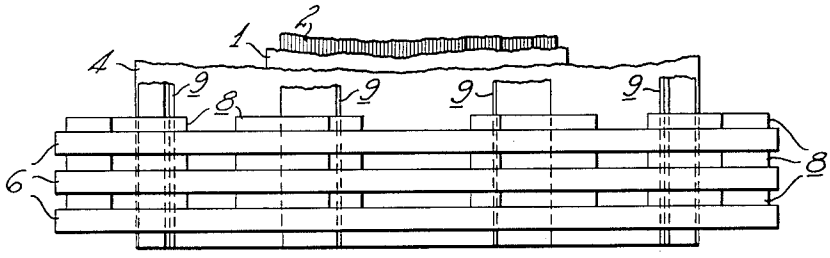


Fig. 2

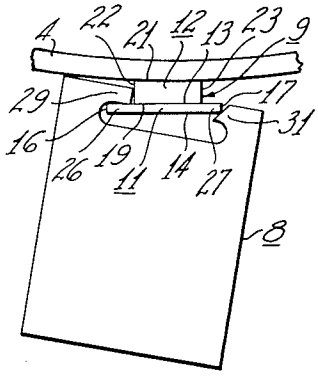


Fig. 3

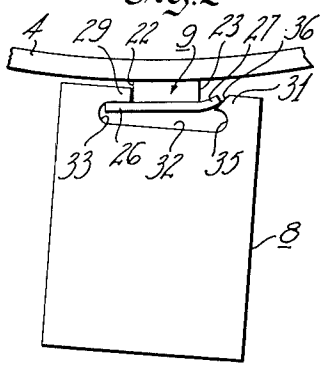


Fig. 4

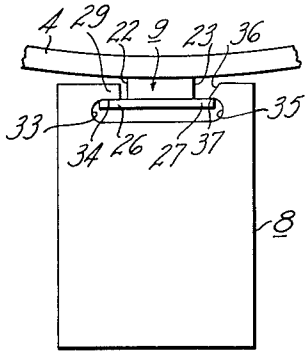


Fig. 5

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MEANS FOR SPACING DISK COILS

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6 Claims. (Cl. 336—60)

This invention relates to electrical induction apparatus and particularly to such apparatus including means for spacing the electrical winding coils. An application of the invention is, for example, in a transformer having disk coils which are separated by radial spacers for the circulation between the coils of a cooling and insulating fluid such as oil.

In prior art transformer construction, spacers having slotted end segments are anchored to and positioned on engaging runners by fitting the slot of each spacer about the end of an associated runner and moving that spacer along the runner until it rests against a coil placed about the runners. Another coil is placed about the runners and is separated from the first coil by the spacers. Other spacers are then disposed to rest against the second coil. This process is repeated until the coil stack is completed. Disadvantages are presented by this prior construction. If, after the core stack has been assembled it is desired to add an additional spacer within the inner part of the stack, the core stack must be disassembled, for a spacer fitted over the end of the runner would be prevented from being moved along the runner to a position within the stack because the spacer would abut the end coil or spacer at the top of the coil.

It is therefore desirable to have a coil spacer which can be inserted between coils and anchored to a runner without first having to engage the spacer to the runner by fitting its slotted segment about the end of a runner and then moving the spacer into position.

Also as the coil stack and runner frequently are several feet high, it is a disadvantage to slide all the spacers along the runner.

It is an object of this invention to provide an electrical induction apparatus with an improved spacer which can be easily and quickly anchored to a runner.

A further object of this invention is to provide a spacer which can be directly anchored to a runner at any desired position without first fitting the spacer to the extreme end of the runner and then moving the spacer along the runner to the desired position.

Another object of this invention is to provide for indicating when a spacer is securely anchored to the runner.

Objects and advantages other than those set forth above will be apparent from the following description when read in connection with the accompanying drawing in which:

Fig. 1 is a plan view of a part of a transformer showing an embodiment of this invention;

Fig. 2 is a partial view in elevation of the transformer shown in Fig. 1;

Fig. 3 is an enlarged plan view showing a spacer and associated runner of the transformer with the spacer positioned with respect to the runner before pressure is applied to snap the spacer on the runner;

Fig. 4 is another enlarged view showing the positioning of the spacer with respect to the runner when pressure is applied in the process of snapping the spacer on the runner; and

Fig. 5 is a third enlarged view showing the positioning

of a spacer with respect to a runner when the spacer is securely anchored to the runner.

The embodiment shown discloses a transformer in which a cylindrical insulating barrier 1 surrounds a magnetic core 2 and isolates that core from low voltage winding 3. Surrounding the low voltage winding is another cylindrical insulating barrier 4 which is within high voltage winding 6 and which isolates the low voltage winding from the high voltage winding.

The high voltage winding comprises winding sections spaced apart axially and shown in the form of disk coils 6 surrounding the core. The disk coils are spaced apart by spacers 8 extending longitudinally radially between those coils. The spacers are securely anchored and kept aligned by elements affixed to the electrical apparatus substantially parallel to the axis of the coils; such as runners 9, affixed to the outside of barrier 4.

A runner is formed with a generally T-shaped cross section from one solid piece or from component parts fastened together. In the embodiment shown the runner comprises a keeper strip 11 and a backup strip 12. Each of these strips is of insulating material. The keeper strip has a first face 13, a second face 14, a first longitudinal edge 16 and a second longitudinal edge 17 and defines a rectangular cross section with the faces opposite each other and the edges opposite each other. The backup strip likewise has a rectangular cross section with a first face 19, a second face 21, a first longitudinal edge 22 and a second longitudinal edge 23. These strips are fastened to each other. Face 19 of the backup strip is rigidly affixed to face 13 of the keeper strip with the longitudinal axis of the keeper strip being parallel to the longitudinal axis of the backup strip. Edges 22 and 23 of backup strip 12 are wider than edges 16 and 17 of keeper strip 11. Faces 19 and 21 of the backup strip are of lesser width than faces 13 and 14 of the keeper strip. The backup strip having the narrower width is so fastened to keeper strip 11 that the latter has a first portion 26 and a second portion 27 extending laterally from longitudinal edges 22 and 23 of the backup strip. At least one of these portions is flexible. In the embodiment both portions 26 and 27 are flexible. With both portions flexible, spacer 8 can be anchored to runner 9 regardless of whether the spacer is inserted right side up or upside down.

The base of the T-shaped element or face 21 of backup strip 12 is rigidly affixed to the outside of barrier 4 in the longitudinal direction of the barrier. The keeper strip (or cross arm of the element) is maintained a distance from barrier 4 equal to the thickness of the backup strip as defined by the width of edges 22 and 23.

Spacer 8 is made of insulating material and is rectangular in shape in the embodiment shown. An end segment of that spacer has a T-shaped slot forming first lip 29 and second lip 31 spaced apart a distance less than the width of the faces of the keeper strip. A groove of a size greater than the cross section of keeper strip 11 is defined by the spacer within the end segment. The groove is therefore large enough to contain the keeper strip.

The lips of spacer 8 are of a particular shape and disposed in certain positions in the preferred embodiment. Lip 29 is opposite lip 31 and overhangs end section 33 of the groove. Inner base surfaces 34 and 37 of the lips are disposed to make angles with a plane transverse the radial length of the spacer less than the angle of friction between the base surfaces and the end portions of the keeper. Preferably that base surface is in that plane as shown, thus the angle is zero degrees. Lip 31 overhangs opposite end section 35 of the groove and has outer surface 36 diverging or sloped outward from lip 29 and in a direction away from the groove. The least angle of the slope is greater than the angle of

friction between surface 36 and flexible portion 27 of keeper strip 11. The angle shown is substantially 45°.

The positioning of spacer 8 with respect to keeper strip 11 before the spacer is anchored to the keeper is shown by Fig. 3. Edges 22 and 23 are wide enough to keep keeper strip 11 a sufficient distance from barrier 4 to permit engagement of that strip with the slotted part of spacer 8. Portion 26 is disposed within end section 33 of groove 32. Lip 29 abuts longitudinal edge 22 of backup strip 12 with flexible portion 27 simultaneously abutting surface 36 of lip 31. The spacer is permitted to be cocked slightly clockwise, as viewed, for the width dimension of lip 29 is less than the distance of keeper 11 from the barrier. In anchoring the spacer pressure is exerted, through surface 36, on flexible portion 27 flexing that portion as shown by Fig. 4. The angle of friction between surface 36 and portion 27 when pressure is exerted is less than the 45° angle of surface 36. Therefore, portion 27 is caused to slide past surface 36 and become disposed within opposite end section 35 of the groove as shown by Fig. 5.

The person inserting spacers 8 between disk coils is given notice when those spacers are securely anchored to runner 9. A click is audible when flexible portion 27 is securely disposed within end section 35 of the groove. This noise is caused by flexible portion 27 unflexing after it slides past surface 36 into end section 35. It is also partially caused by the flexible portion striking the bottom of the groove.

Once the spacers are snapped into position they are securely anchored to the runner. This is so because base surfaces 34 and 37 of the spacer lips form angles of zero degrees with a plane transverse the longitudinal axis of spacer 8 which is less than the angle of friction of the base surfaces in abutment with end portions 26 and 27 upon pressure being exerted to pull the spacer from the keeper. The keeper strip is also prevented from shifting far enough within the groove to allow either of longitudinal edges 16 or 17 from going beyond base surfaces 34 or 37, respectively, and escaping from the groove via the space between the lips of the spacer. In the embodiment shown, longitudinal edge 22 would abut lip 29 and longitudinal edge 17 would abut that part of the spacer defining end section 33 of the groove before the edges of the keeper strip could escape from the groove and into the space between the lips.

To insert spacers between disk coils is therefore easily done with the embodiment shown. Portion 26 is inserted within end section 33 of the groove and the spacer is moved until diverging surface 36 of lip 31 abuts flexible portion 27 of the keeper strip. Pressure is applied through surface 36 on flexible portion 27 by movement of spacer 8. This pressure causes portion 27 to flex and slide past surface 36 into opposite end section 35 of the groove with an audible click. Portions 26 and 27 within the groove abut base surfaces 34 and 37 to securely anchor spacer 8 to runner 9.

Although but one embodiment of the present invention has been illustrated and described it will be apparent to those skilled in the art that changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A transformer comprising a magnetic core, a winding comprising disk coils surrounding said core, a cylindrical insulating barrier within said winding, a runner affixed to said barrier, and a spacer extending longitudinally radially between said disk coils and anchored to said runner, said runner having a keeper strip and a backup strip, each of said strips being of insulating material and having first and second faces and first and second longitudinal edges defining a rectangular cross section, said backup strip having said first and second faces of less width and said first and second longitudinal edges of greater thickness than said first and second faces and said first and second longitudinal edges, respectively, of said keeper strip, said first face of said backup strip rigidly affixed to said first face of said keeper strip with the longitudinal axis of said keeper strip being parallel to the longitudinal axis of said backup strip, said keeper strip having first and second flexible portions extending laterally from said longitudinal edges of said backup strip, said second face of said backup strip being rigidly affixed to said barrier in the longitudinal direction of said barrier with said keeper strip maintained from said barrier a distance equal to the thickness of said edges of said backup strip to allow engagement of said keeper strip with said spacer, said spacer having an end segment with a T-shaped slot to form first and second lips spaced apart a distance less than the width of said faces of said keeper strip and defining a groove of a size greater than the cross section of said keeper strip to contain said keeper strip within said groove, said first lip opposite said second lip and overhanging an end section of said groove, said first flexible portion disposed within said end section, said second lip overhanging an opposite end section of said groove and having a surface diverging at substantially a 45° angle outward from said first of said lips and in a direction away from said groove for engagement by said second flexible portion simultaneously with said first lip abutting said first longitudinal edge of said backup strip, said 45° angle being greater than the angle of friction of said diverging surface and said second flexible portion upon pressure being exerted to cause said second flexible portion to flex, slide past said second lip and become disposed within said opposite end section, one of said longitudinal edges of said keeper strip in abutment with that part of said spacer defining one of the end sections of the groove, first and second base surfaces of said first and second lips, respectively, forming second angles with a plane transverse the longitudinal axis of said spacer, said second angles being less than the respective angles of friction of said base surfaces in abutment with said flexible portions upon pressure being exerted by said base surfaces on said flexible portions, the abutment of one of said longitudinal edges of said keeper strip with that part of said spacer defining one of the end sections of the groove together with the abutment of said base surfaces with said flexible portions to cause said flexible portions to be retained within said groove and secure said keeper within said spacer.

2. A transformer comprising a magnetic core, a winding comprising disk coils surrounding said core, a cylindrical insulating barrier within said winding, a runner affixed to said barrier, and a spacer extending longitudinally radially between said disk coils and anchored to said runner, said runner having a keeper strip and a backup strip, each of said strips being of insulating material and having first and second faces and first and second longitudinal edges defining a rectangular cross section, said backup strip having said first and second faces of lesser width and said first and second longitudinal edges of greater thickness than said first and second faces and said first and second longitudinal edges, respectively, of said keeper strip, said first face of said backup strip rigidly affixed to said first face of said keeper strip with the longitudinal axis of said keeper strip being parallel to the longitudinal axis of said backup strip, said keeper strip having first and second flexible portions extending laterally from said longitudinal edges of said backup strip, said second face of said backup strip being rigidly affixed to said barrier in the longitudinal direction of said barrier with said keeper strip maintained from said barrier a distance equal to the thickness of said edges of said backup strip, said spacer having an end segment with a T-shaped slot to form first and second lips spaced apart a distance less than the width of said faces of said keeper strip and defining

a groove of a size greater than the cross section of said keeper strip to contain said keeper strip within said groove, said first lip having width dimensions less than the thickness of said edges of said backup strip to permit insertion of said first lip between said keeper strip and said barrier is opposite said second lip and overhangs an end section of said groove and having a first base surface disposed in a plane transverse the longitudinal axis of said spacer forming an angle of zero degrees with that plane, said first flexible portion disposed within said end section, said second lip overhanging an opposite end section of said groove and having a surface diverging at substantially a 45° angle outward from said first of said lips and in a direction away from said groove for engagement by said second flexible portion with said angle being greater than the angle of friction between said diverging surface and said second flexible portion upon pressure being exerted to cause said second flexible portion to flex, slide past said second lip and become disposed within said opposite end section with an audible click, a second base surface of said second lip forming an angle of zero degrees with a plane transverse the longitudinal axis of said spacer that said second flexible portion is caused to be retained within said groove and together with said first portion abutting said first base surface securing said keeper within said spacer.

3. An electrical induction apparatus comprising a magnetic core, a winding comprising disk coils surrounding said core, an insulating barrier within said winding, a runner affixed to said barrier, and a spacer extending longitudinally radially between said disk coils and anchored to said runner, said runner having a keeper strip and a backup strip, each of said strips having opposite faces and opposite longitudinal edges, said backup strip having said opposite faces of lesser width and said opposite longitudinal edges of greater thickness than said opposite faces and said opposite longitudinal edges, respectively, of said keeper strip, a face of said backup strip rigidly affixed to a face of said keeper strip with the longitudinal axis of said keeper strip being parallel to the longitudinal axis of said backup strip, said keeper strip having first and second flexible portions extending laterally from said longitudinal edges of said backup strip, the opposite face of said backup strip being rigidly affixed to said barrier in the longitudinal direction of said barrier with said keeper strip maintained from said barrier a distance equal to the thickness of said edges of said backup strip, said spacer having an end segment with a T-shaped slot to form first and second lips spaced apart a distance less than the width of said faces of said keeper strip and defining a groove of a size greater than the cross section of said keeper strip to contain said keeper strip within said groove, said first lip having width dimensions less than the thickness of said edges of said backup strip to permit insertion of said first lip between said keeper strip and said barrier is opposite said second lip and overhangs an end section of said groove, said first flexible portion disposed within the end section of the groove, said second lip overhanging an opposite end section of the groove and having a surface diverging outward at a first angle from said first of said lips and in a direction away from the groove for engagement by said second flexible portion with said first angle being greater than the angle of friction of said diverging surface and said second flexible portion upon pressure being exerted to cause said second flexible portion to flex, slide past said second lip and become disposed within the opposite end section of the groove, a first base surface of said first lip and a second base surface of said second lip, said base surfaces forming angles with a plane transverse the longitudinal axis of said spacer with said angles being less than the angles of friction between said base surfaces and said portions upon pressure being exerted by said base surfaces on said portions that said portions are caused to be retained within said groove securing said keeper within said spacer.

4. An electrical induction apparatus comprising a magnetic core, first and second winding sections spaced apart axially and surrounding said core, an insulating barrier within said winding sections, a runner affixed to said barrier, and a spacer extending longitudinally radially between said first and second winding sections and anchored to said runner, said runner having a keeper strip and a backup strip, said backup strip rigidly affixed to said keeper strip with the longitudinal axis of said backup strip being substantially parallel to the longitudinal axis of said keeper strip and with a first portion and a second flexible portion of said keeper strip extending laterally from said backup strip, said backup strip affixed to said barrier in substantially the longitudinal direction of said barrier and maintaining said keeper strip a fixed distance from said barrier to allow engagement of said keeper strip with said spacer, said spacer having an end segment with a slot to form first and second lips spaced apart a distance less than the width of said keeper strip and defining a groove to contain said keeper strip, said first lip opposite said second lip overhanging an end section of said groove and having a first base surface disposed in a plane transverse the longitudinal axis of said spacer, said first portion disposed within said end section, said second lip overhanging an opposite end section of said groove and having a surface diverging outward at a first angle from said first of said lips and in a direction away from said groove for engagement by said second flexible portion with said first angle being greater than the angle of friction of said diverging surface and said second flexible portion upon pressure being exerted to cause said second flexible portion to flex, slide past said second lip and become disposed within said opposite end section, a second base surface of said second lip forming a second angle with a plane transverse the longitudinal axis of said spacer with said second angle being less than the angle of friction between said second base surface and said second flexible portion upon pressure being exerted by said second base surface on said second flexible portion to cause said second flexible portion to be retained within said groove and together with said first portion abutting said first base surface securing said keeper within said spacer.

5. An electrical induction apparatus comprising a magnetic core, a winding including first and second sections spaced apart axially and surrounding said core, a generally T-shaped element affixed at its base with its cross arm having a first end portion and a second flexible end portion and a spacer extending longitudinally radially between said first and second sections and anchored to said element, said spacer having an end segment with a T-shaped slot to form first and second lips spaced apart a distance less than the cross arm of said element and defining a groove to contain the cross arm of said element, said first lip opposite said second lip and overhanging an end section of the groove, said first portion disposed within said end section, said second lip overhanging an opposite end section of the groove and having a surface diverging outward from said first of said lips and in a direction away from the groove for engagement by said second flexible portion with the slope of said diverging surface being greater than the angle of friction between said diverging surface and said second flexible portion upon pressure being exerted that said second flexible portion is caused to flex, slide past said second lip and become disposed within said opposite end section, first and second base surfaces of said first and second lips, respectively, forming angles with a plane transverse said spacer less than the angle of friction of said base surfaces and said first portions upon pressure being exerted through said base surfaces on said portions that said portions are caused to be retained within the groove securing the cross arm of said element within said spacer.

6. An electrical induction apparatus comprising a magnetic core including first and second sections spaced apart axially and surrounding said core, a generally T-shaped element affixed at its base to said apparatus with its cross arm having a first end portion and a second flexible end portion, and a spacer extending longitudinally radially between said first and second sections and anchored to said element, said spacer having an end segment with a T-shaped slot to form first and second lips spaced apart a distance less than the cross arm of said element and defining a groove to contain the cross arm of said element, said first lip opposite said second lip and overhanging an end section of the groove, said first portion disposed within said end section, said second lip overhanging an opposite end section of the groove and having a surface diverging outward from said first of said lips and in a direction away from the groove for engagement by said second flexible portion which is caused to flex, slide past said second lip and become disposed within the opposite end section by force being exerted through said diverging surface, first and second base surfaces of said first and second lips, said first and second portions in abutment with said first and second base surfaces, respectively, thereby causing said portions to be retained within the groove securing the cross arms of said element within said spacer.

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