

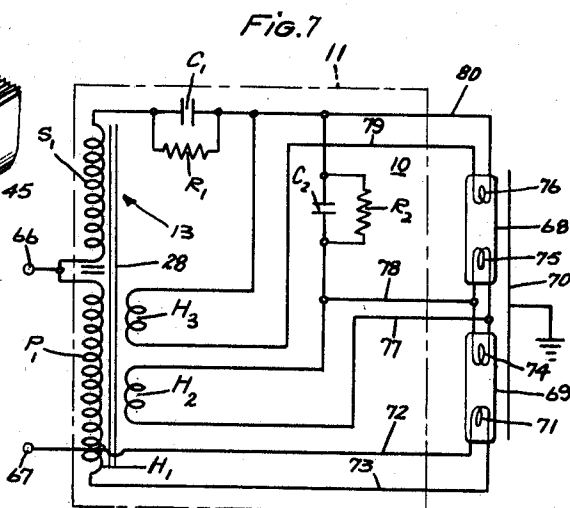
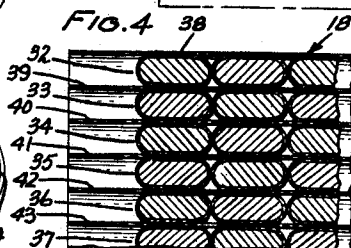
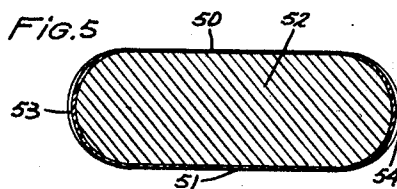
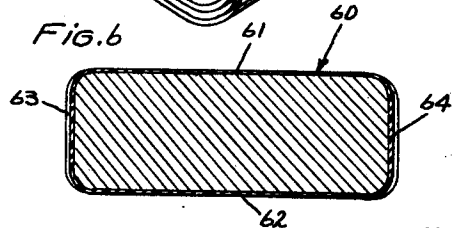
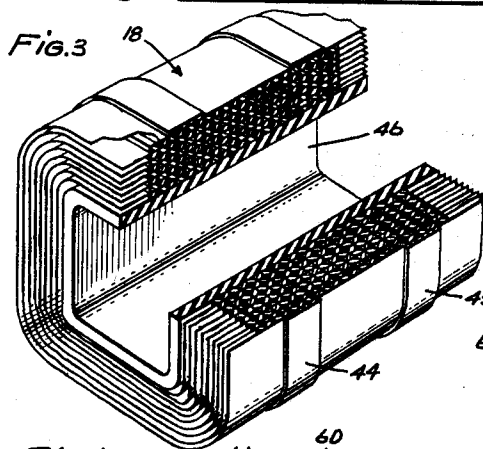
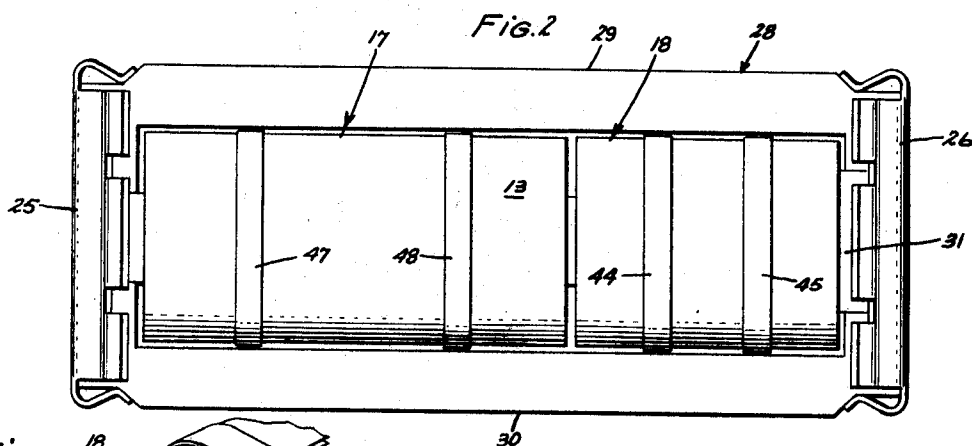
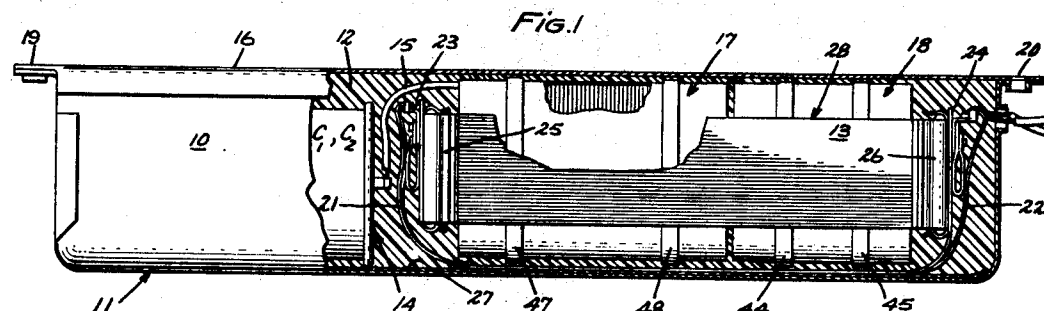
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APPARATUS FOR STARTING AND OPERATING ELECTRIC DISCHARGE LAMPS

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APPARATUS FOR STARTING AND OPERATING ELECTRIC DISCHARGE LAMPS

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2 Claims

ABSTRACT OF THE DISCLOSURE

An electrical discharge lamp ballast apparatus employing a high leakage reactance type of transformer with a shell type magnetic core and electrical coils wound of turns of insulated wire flattened on the sides to form an essentially oblong cross section with opposed elongated interlayer insulating portions extending in an axial direction with respect to the coil and adjacent to the layer insulation of the coil. With the flattened wire coil arrangement the thermal performance of the ballast apparatus can be uprated, and aluminum wire can be more economically utilized in a ballast apparatus. Preferably, a polymeric amide resin is used as an insulating material for the flattened conductor wire.

BACKGROUND OF THE INVENTION

This invention relates to apparatus for operating electric discharge lamps and more particularly to an improved apparatus employing flattened wire coils.

In the shell type of high leakage reactance transformers used in apparatus for starting and operating electric discharge lamps, i.e., fluorescent lamps, the coils containing the various windings are mounted on a center winding leg, and the side portions of the coils are positioned within the window space provided between the outer yoke members of the core and the center winding leg. The window space dimensions of the magnetic core restrict the cross-sectional dimensions of the coil. It will be appreciated that the cross-sectional area of a ballast case cannot exceed certain standardized cross-sectional dimensions, and thereby a limit is imposed on the cross-sectional dimensions, of the core and coil assembly. In view of these dimensional restrictions, the core and coil assemblies of ballast transformers have a generally elongated configuration.

Coils commonly used in ballast transformers are constructed of superposed layers of insulated circular conductor wire with interleaved layers of paper layer insulation. The superposed layers of turns are formed by winding the circular conductor wire on a suitable rectangular shaped spool made of kraft paper. The paper spool on which the coil turns are wound serves to insulate the turns from the center winding leg of the magnetic core.

In such conventional coils it will be apparent that the window space available in the core is not efficiently utilized because of the circular shape of the conductor wire. Thus, there is a need in a ballast apparatus for a core and coil assembly that will allow more conductive material to be used in window space available in a given magnetic core design. In particular, it would be desirable for better utilization of the core window space to replace copper conductor wire with aluminum wire. Also, it is always desirable in a ballast apparatus to reduce the ballast case temperature.

Accordingly, it is an object of the present invention to provide an improved apparatus for starting and operating electric discharge lamps characterized by a relatively lower operating temperature.

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Another object of the present invention is to provide an improved apparatus for starting and operating electric discharge lamps, such as fluorescent lamps, wherein the better utilization of the window space available in the magnetic core of the apparatus is achieved.

It is a more specific object of the present invention to provide an improved ballast apparatus employing coils wound of aluminum wire.

A further object of the present invention is to provide an improved apparatus for starting and operating electric discharge lamps wherein heat generated by the windings is more efficiently transferred from the coils.

SUMMARY OF THE INVENTION

In accordance with one form of my invention, I have provided a ballast apparatus that includes a high leakage reactance inductive device commonly called a reactor or transformer. The reactor or transformer has a magnetic core formed having a center winding leg and side yoke members to define coil receiving windows. Coil assemblies are mounted on the center winding leg of the magnetic core with portions thereof disposed within the coil receiving windows and are wound of turns of conductor wire flattened on at least two sides to form an essentially oblong cross section with opposed interlayer insulating portions and interconductor insulating portions. The transverse length of the interlayer insulating portions is greater than the length of the interconductor insulating portions.

In a more specific aspect of my invention, the metallic conductor of the conductor wire is preferably comprised of aluminum and is coated with a polymeric amide resin. Also, the interconductor insulating portions of the flattened wire preferably have a thickness greater than the thickness of the interlayer insulating portions.

The subject matter which I regard as my invention is set forth in the appended claims. The invention itself, however, together with further aspects, objects and advantages thereof may be better understood by referring to the following description taken in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 is a front elevational view of a ballast apparatus with the potting compound and parts sectionalized in part to show the coil conductor wire and insulation layers of one of the coil assemblies;

FIGURE 2 is an enlarged plan view of the magnetic core, and coil assembly as shown in FIGURE 1;

FIGURE 3 is an enlarged sectionalized view in perspective of one of the ballast coil assemblies shown in FIGURES 1 and 2;

FIGURE 4 is a magnified view of a corner portion of the sectionalized coil assembly shown in FIGURE 3;

FIGURE 5 is a magnified view of a cross section of a single conductor wire used in the embodiments of the invention shown in FIGURES 1 through 4;

FIGURE 6 is a magnified view of a cross section of conductor wire flattened at four sides that can be used in the practice of the invention; and

FIGURE 7 is a schematic circuit diagram of a ballast apparatus embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Having more particular reference now to FIGURE 1, I have illustrated therein a ballast apparatus 10 for starting and operating fluorescent lamps. As shown in FIGURE 1, the ballast apparatus 10 has a portion of the ballast case 11 and potting material 12 cut away to show the internal arrangement of the components. The circuit

connections of the components of the ballast apparatus 10 can be best seen in the schematic circuit diagram of FIGURE 7 which will be hereinafter more fully described.

It will be seen in FIGURE 1 that ballast apparatus 10 includes a core and coil assembly 13, a capacitor case 14 containing the power and start capacitors C_1 and C_2 , and leads 15, all of the components being potted in ballast case 11 with a suitable potting material such as mixtures of asphaltic compounds and silica. The ballast case 11 includes a cover plate 16, which preferably is placed close to one side of coil assemblies 17, 18 to provide for efficient heat transfer from the coil assemblies 17, 18 to the outside environment. It will be appreciated that the ballast apparatus 10 is usually attached to a lamp fixture by securing the flanged portions 19 and 20 of the case 11 to the lamp fixture. The lamp fixture generally serves as a heat sink for the heat generated within the ballast apparatus 10, the main path of the heat transfer being generally through the cover plate 16. The leads 21, 22 brought out from coil assemblies 17, 18 to terminals 23, 24 on core clamps 25, 26 are insulated from the ballast case 11 by a strip of ground insulation 27 which extends along the length of ballast case 11.

Referring now more specifically to FIGURES 2, 3 and 4, I have shown therein various views of the coil assemblies 17 and 18, the connections of these coil assemblies and terminal pads being omitted in the interest of simplification. As will be seen in the view of FIGURE 2, the coil assemblies 17, 18 are mounted on a magnetic core 28 comprised of a pair of outer yoke members 29, 30 and a center winding leg 31 on which the coil assemblies 17, 18 are supported. The core clamps 25, 26 hold the side yoke members 29, 30 and the center winding leg 31 in assembled relation. The side yoke members 29, 30 and center winding leg 31 are formed of stacks of horizontally extending laminations punched from sheet magnetic material.

As will be seen in FIGURES 3 and 4, coil assembly 18 is formed of a plurality of superposed layers of insulated conductor wire. Conductor wire layers 32, 33, 34, 35, 36 and 37 are interleaved with insulation layers 38, 39, 40, 41, 42 and 43 formed of vegetable parchment approximately .002 of an inch in thickness. It will be appreciated that the paper insulation layers minimize the effect of voltage stress between conductor wire layers by providing an insulating barrier between the conductor wire layers. Further, it will be seen that the paper insulation layers extend beyond the outer turns in each conductor wire layer. These extensions of the insulation layers provide a spacing between the end turns and the adjacent parts of the magnetic core thereby preventing the end turns from grounding by contacting the magnetic core 28. Also, the end turns of the conductor wire layers are held in position by the extensions. An important advantage of the improved flattened wire coil arrangement is that the length of these extensions can be reduced, as compared with prior art ballast coil assemblies with paper layer insulation.

Coil assembly 18 contains the primary winding and the cathode heating windings which are wound over the primary winding on a spool 46. It will be seen that the spool 46 is formed of insulating material and has an axial opening which is adapted for mounting the center winding leg 31 of the magnetic core. Strips of pressure sensitive tape 44 and 45 prevent the outer insulation layers from unravelling. Coil assembly 17 contains the secondary winding turns and is of identical construction to coil assembly 18 and is constructed of superposed layers of turns of insulated conductor wire separated by paper insulation layers in the same manner as is illustrated in FIGURE 4. The outer paper insulation layer of coil assembly 17 is held in place by means of pressure sensitive tape strips 47 and 48.

It will be appreciated that the circuit connections with the coil assemblies, which are shown schematically in FIGURE 7, are made by bringing out start and finish leads to terminal pads. For a more detailed description of a typical terminal lead arrangement which may be used in making such circuit connections, reference may be had to U.S. Patent No. 3,217,278 issued to G. W. Beckes et al., and assigned to the assignee of the present invention.

In the magnified view of the corner portion of coil assembly 18 as shown in FIGURE 4, it will be noted that the insulated conductor wire which forms layers 32, 33, 34, 35, 36 and 37 has a generally oblong cross-sectional configuration with a pair of flattened opposed sides. More specifically, the conductor wire has the cross-sectional configuration shown in FIGURE 5. The opposed interlayer insulating portions 50 and 51 are formed by flattening the metallic conductor 52 to provide the desired flattening ratio (ratio of the transverse length to the height of the wire cross section). The interconductor insulating portions 53 and 54 are generally oval in shape and have a thickness that is slightly greater than the thickness of the interlayer insulating portions 50, 51.

The metallic conductor 52 used in the exemplification of my invention is aluminum, and the resin insulation is a polymeric amide resin. This resin is produced from the polymerization of a dibasic acid and a diamine, the amide groups forming an integral part of the main polymer chain. This resin is a preferred insulating resin since it is a relatively tough, strong and elastic material, and flattening wire insulated with this resin does not materially affect these properties. In the flattening process the enamel resin insulating material on the insulated conductor material tends to build up at the side portions and thereby provides additional insulation where it is needed.

By way of further exemplification of my invention, four designs of a ballast apparatus 10 for operating two 40 watt fluorescent lamps embodying the improved flattened coil arrangement and utilizing coils with different flattening ratios are summarized in Table I below.

TABLE I

	Design			
	A	B	C	D
Coil Assembly 17:				
Flattening ratio.....	1.63	2.45	1.61	3.01
Wire size (inches).....	.0159	.0159	.0169	.0179
Coil Assembly 18:				
Flattening ratio.....	1.69	3.50	1.64	3.95
Wire size (inches).....	.0169	.0169	.0179	.0190
Total material weight for core and coil assembly 13:				
Aluminum (pounds).....	.182	.184	.205	.232
Core steel (pounds).....	1.32	1.30	1.54	1.54

It will be appreciated that a coil and core of a comparable prior art ballast apparatus for operating two 40 watt fluorescent lamps contain approximately .404 pound of copper and 1.21 pounds of steel and because of the higher copper content is more expensive to produce. The cost of the aluminum and steel based on present day prices of these materials in the designs A, B, C and D of Table I are significantly less. Also, it can be expected that designs C and D would have appreciably lower case temperature than the conventional ballast with circular copper wire coils. For design C a reduction of 4 to 5 degrees centigrade and for design D a reduction of 8 to 10 degrees centigrade in case temperature can be achieved.

In the view shown in FIGURE 6, I have illustrated a modification of a conductor wire configuration that can be employed in the practice of my invention wherein insulated conductor wire 60 is flattened at four sides to provide a more rectangular oblong configuration. When the flattened wire 60 is used in a ballast apparatus, it is possible to achieve a further improvement in the coil space factor by also flattening the sides that adjoin adja-

cent conductors in a layer and thereby increase the amount of conductive material in a given length of conductor wire layer. The opposed interlayer insulating portions 61, 62 and the opposed interconductor insulating portions 63, 64 are relatively flat. When the conductor wire 60 is flattened at four sides, depending on the physical properties of the resin insulation, a build-up of insulating material may occur at the corners.

Referring now more particularly to the schematic circuit diagram illustrated in FIGURE 7, I have identified the ballast apparatus by same reference numeral 10. The ballast apparatus 10 is shown enclosed in a dashed rectangle 11 which represents the ballast case. It will be seen that the parts of the core and coil assembly 13 are shown schematically and include the magnetic core 28, a primary winding P₁, a secondary winding S₁ inductively coupled on the magnetic core 28, and cathode heating windings H₁, H₂, and H₃. A pair of input terminals 66, 67 are provided for connection to a suitable alternating power source (not shown) such as a 60 cycle, 120 volt alternating current supply.

The fluorescent lamps 68, 69 operated by the ballast apparatus 10 are of the rapid start type and are preferably positioned in close proximity to a grounded conductive fixture or plate 70 so that the lamps 68, 69 are disposed in capacitive relationship with respect to the fixture or plate 70. A flux leakage path is generally provided between the primary winding P₁ and the secondary winding S₁ and may be formed through nonmagnetic material, such as air, or through magnetic material.

Continuing further with the description of the circuit connections, it will be seen that the cathode heating windings H₁, H₂, and H₃ continually supply the filaments of fluorescent lamps 68 and 69 with heating current during operation. Cathode heating winding H₁, which is an extension of the primary winding P₁, is connected in circuit with filament 71 by leads 72, 73. Cathode heating windings H₂ and H₃ are connected in circuit with filaments 74, 75 and 76 by leads 77, 78, 79 and 80. Cathode heating windings H₂, H₃ are preferably tightly coupled with the primary winding P₁ and may, if desired, be wound directly over the primary winding.

One end of the secondary winding S₁ is connected in circuit with the primary winding P₁ in autotransformer relationship. The other end of the secondary winding S₁ is connected in circuit with the series capacitor C₁, which provides a net capacitive reactance in the lamp circuit. A starting capacitor C₂ is connected across lamp 68 so that the open circuit starting voltage is initially applied across lamp 69. Resistors R₁ and R₂, which shunt the series capacitor C₁ and the starting capacitor C₂, are bleeding resistors and cause the charge to be bled off the capacitors C₁, C₂ when the circuit is deenergized.

The advantages of the present invention can be realized in a ballast apparatus for starting and operating a single fluorescent lamp as well as for starting and operating two or more fluorescent lamps. Further, it will be appreciated that the advantages for the present invention can be used with a magnetic core and coil assembly having more than two coil assemblies.

Although the present invention is described with reference to particular embodiments thereof, it will be understood that many modifications may be made therein by those skilled in the art without departing from the scope of the invention. It is therefore intended in the appended

claims to cover such modifications that 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. In a ballast apparatus for operating at least one electric discharge lamp from an alternating power source, said ballast apparatus including a transformer having a magnetic core formed with a center winding leg and side yoke members, said side yoke members and said center winding leg defining coil receiving windows, the improvement comprising: a pair of coil assemblies mounted on the center winding leg with portions of said coil assemblies disposed within the coil receiving windows, one of said coil assemblies including at least a primary winding and the other of said coil assemblies including at least a secondary winding, said primary and secondary winding being inductively coupled on the magnetic core, at least one of said coil assemblies including a plurality of turns of conductor wire having a metallic conductor and an insulating coating, and said conductor wire wound to form layers of conductor wire and flattened on at least two sides thereof to form an essentially oblong cross section with opposed interlayer insulating portions formed of said insulating coating and interconductor insulating portions formed of said insulating coating, said interconductor insulating portions have a thickness greater than the thickness of the interlayer insulating portions.

2. In a ballast apparatus for operating at least one electric discharge device from an alternating current source, said ballast apparatus including a reactor having a magnetic core formed with winding leg and side members, the improvement comprising: at least one coil assembly mounted on said winding leg of the magnetic core, said at least one coil assembly comprised of turns of conductor wire formed of a metallic conductor with an oblong cross section and having an insulating coating, said at least one coil assembly being wound to provide turns of conductor wire arranged in layers with layer insulation interleaved therebetween to electrically insulate the layers of conductor wire with said conductor wire flattened on at least two sides to form from said insulating coating elongated interlayer insulating portions adjacent to the layer insulation and to form from said insulating coating interconductor insulating portions for insulating adjacent conductor wires in said layers of conductor wire, said interconductor insulating portions have a thickness greater than the thickness of said elongated interlayer insulating portions for insulating adjacent metallic conductors in said layers of conductor wire.

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U.S. Cl. X.R.

174—119; 336—206, 223