

[54] CAPACITIVE INDUCTIVE WINDING
[72] Inventor: Gabor Szatmari, 190 Bartley Bull
Parkway, Brampton, Ontario,
Canada
[22] Filed: Feb. 16, 1971
[21] Appl. No.: 115,479
[52] U.S. Cl. 336/69, 336/180, 336/223
[51] Int. Cl. H01f 15/14
[58] Field of Search.....336/69, 180, 70, 182, 183,
336/223

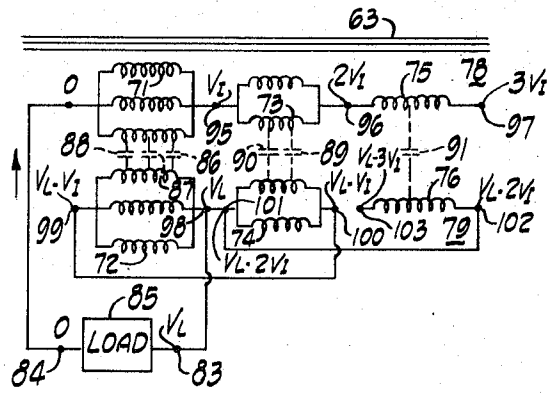
[56] References Cited

UNITED STATES PATENTS			
3,210,706	10/1965	Book	336/69 X
3,078,411	2/1963	Book.....	336/69 UX
3,210,704	10/1965	Book	336/69 X
3,210,705	10/1965	Lockie.....	336/69 X
3,209,241	9/1965	Book et al.....	336/70 X
2,521,513	9/1950	Gray.....	336/183 X
3,210,703	10/1965	Lockie.....	336/69 X

Primary Examiner—Thomas J. Kozma
Attorney—Woodling, Krost, Granger & Rust

[57] ABSTRACT
An improved capacitive inductive winding is disclosed for use with devices requiring an inductance and a series or shunt capacitance. The disclosed invention is a high reactance winding having a nearly uniform current density within the conductive foils, and having a substantially increased capacitance and volt-ampere capacity over the prior art. The invention is suitable for use with devices requiring a high starting voltage and a constant wattage operation such as gaseous discharge devices. The invention is also applicable for use with voltage and wattage regulators, ballasts and ferro-resonant transformers. The foregoing abstract is merely a resume of one general application, is not a complete discussion of all principles of operation or applications, and is not to be construed as a limitation on the scope of the claimed subject matter.

28 Claims, 8 Drawing Figures



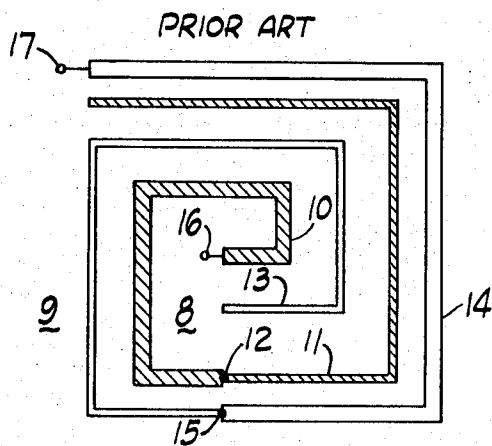


Fig. 1

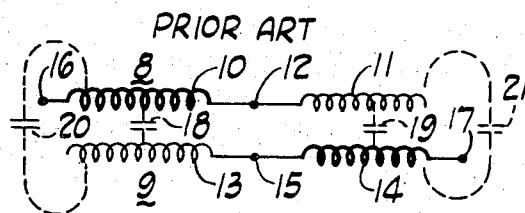


Fig. 2

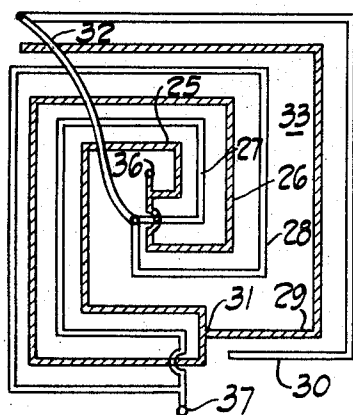


Fig. 3

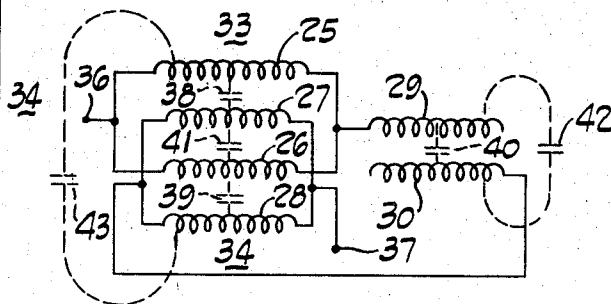


Fig. 4

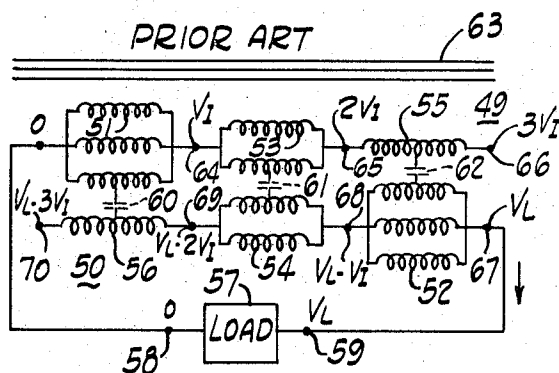
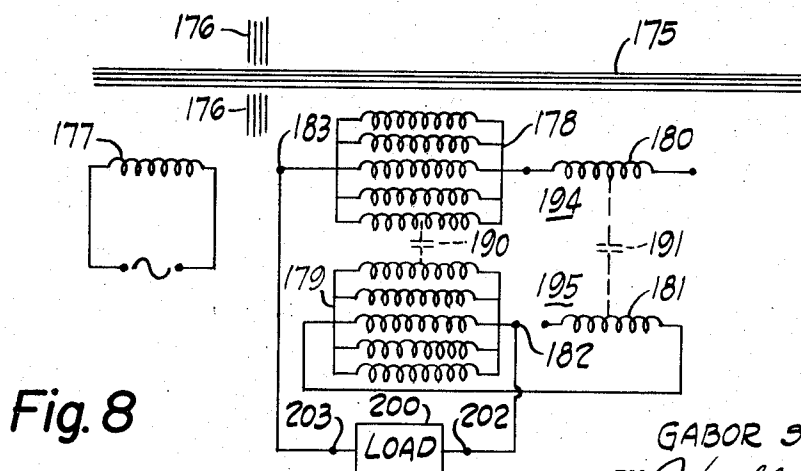
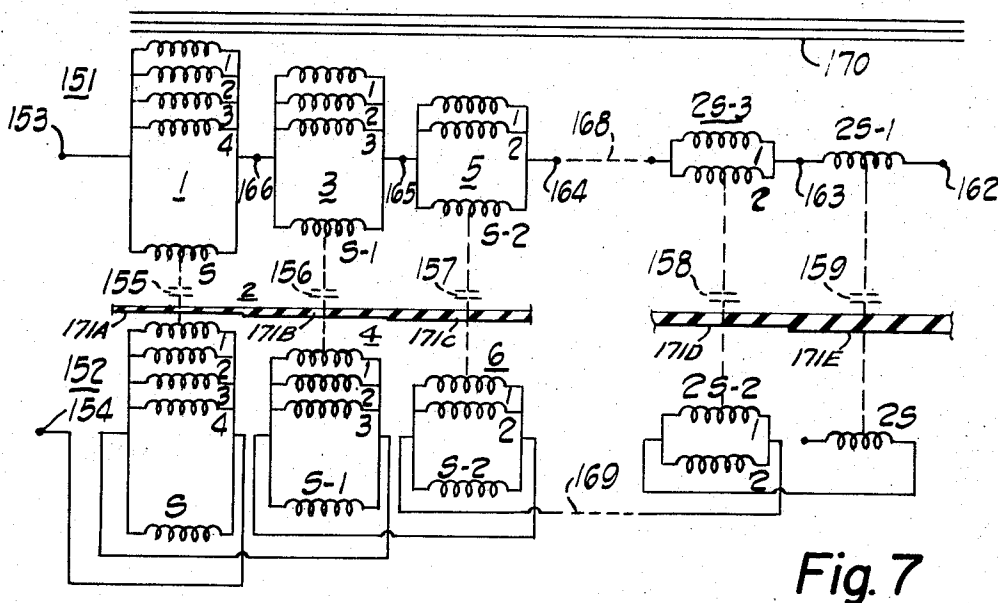
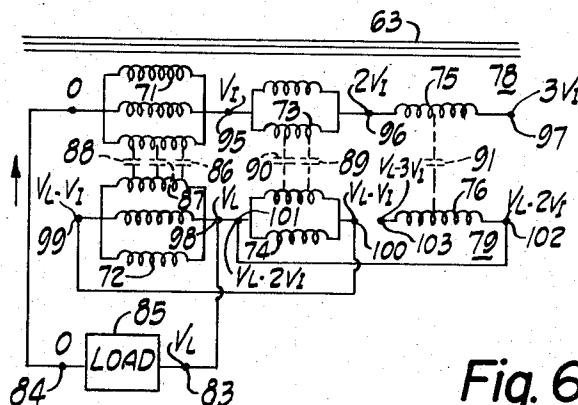


Fig. 5

INVENTOR.
GABOR SZATMARI
BY *Woodling, Krost,
Gronge and Rust*
ATTORNEYS.



INVENTOR.
GABOR SZATMARI
BY *Woodling, Knost,
Gange and Rust*
ATTORNEYS.

CAPACITIVE INDUCTIVE WINDING

BACKGROUND OF THE INVENTION

Constant wattage transformers suitable to start and operate gaseous devices have long been in use. The most primitive of these devices were combinations of high reactance transformers with one or more external capacitors arranged in series, parallel or series-parallel.

The next advancement in the art of high reactance transformers was the advent of the integrated transformers. In the integrated transformers, the capacitance of the secondary circuit is no longer an external component but an integral part of the transformer secondary coil by interleaved foils. However, in these integrated transformers, the capacitive inductive windings do not generate internal heat in the same manner as a conventional transformer winding. In a conventional transformer winding with a wire conductor, the current density is uniform throughout the winding. This results in a uniform heating of that winding.

In a capacitive inductive winding, the winding usually consists of two or more conductive foils separated by the same number of dielectric sheets. The current density is not uniform from one end of a given foil to the other. This non-uniformity is caused by displacement currents through the dielectric that transfer capacitive current from a given foil to an adjacent foil along the length of the foil.

The final advancement in the development of high reactance windings was to reinforce the winding by paralleling two or more layers of foil in areas where the larger current required more cross-sectional area. This advancement produced a more uniform current density through the foil but did not increase the capacitance of the winding over the prior art. In addition, this method of producing a high reactance winding is a difficult task with available coil winding equipment.

Accordingly, an object of the invention is to provide a capacitive inductive winding with a nearly uniform current density to the inputs of the sections of each of the foils.

Another object of the invention is to provide a capacitive inductive winding with more uniform internal heat production.

Another object of the invention is to provide a capacitive inductive winding which has an increased capacitance over the prior art.

Another object of the invention is to produce a capacitive inductive winding using a minimum amount of foil thus reducing material costs.

Another object of the invention is to produce a capacitive inductive winding which is less in weight and size than the prior art windings with the same volt-ampere capacity.

Another object of the invention is to produce a capacitive inductive winding which is easy to wind on existing winding equipment.

SUMMARY OF THE INVENTION

The invention may be incorporated in a capacitive inductive winding, comprising in combination, first and second foil means each having first and second end sections, means establishing a larger current carrying ability at said first end sections than at said second end sections of each of said first and second foil means, and graded capacitance means establishing a larger

capacitance between said first end sections of said first and second foil means than at said second end sections of said foil means.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view of a prior art capacitive inductive winding;

FIG. 2 is a schematic diagram of the prior art winding as shown in FIG. 1;

FIG. 3 is a cross-sectional view of the preferred embodiment of the invention of a capacitive inductive winding;

FIG. 4 is a schematic diagram of the preferred embodiment of FIG. 3;

FIG. 5 is a schematic diagram of a prior art winding divided into three sections;

FIG. 6 is a schematic diagram of a winding divided into three sections and which incorporates the invention;

FIG. 7 is a schematic diagram of a capacitive inductive winding which is an extension of the invention shown in FIG. 4;

FIG. 8 is a schematic diagram of a constant wattage transformer incorporating the present invention.

DESCRIPTION OF DRAWINGS

FIG. 1 is a capacitive inductive winding known to the prior art. The winding consists of two sectionalized foils 8 and 9. These foils are separated by a dielectric which is not shown. The first foil 8 is composed of sections 10 and 11 which are interconnected at connection point 12. Section 10 is illustrated as a heavy conductor, whereas section 11 is illustrated as a light conductor. The second sectionalized foil 9 is composed of light section 13 connected in series with heavy section 14 at connection point 15. Each of the unconnected ends of heavy sections 10 and 14 are connected to terminals 16 and 17, respectively.

FIG. 2 is a schematic diagram of the winding shown in FIG. 1. The heavy sections 10 and 14 and the light sections 11 and 13 are shown as coils in this figure to illustrate their inductive property. The phantom capacitors 18, 19, 20 and 21 illustrate the capacitance inherently formed by the foils separated by a dielectric, not shown. Capacitances 18 and 19 are formed when the first and second foils 8 and 9 are in parallel planes and are separated by a dielectric. When this combination is rolled into the form of a coil, the additional capacitances 20 and 21 are created between adjacent windings. In the usual winding, there are many turns on the sections 10-13 and 11-14, but only one turn is shown in FIG. 1, for simplicity. The first and second foils are now interleaved forming the additional capacitances 20 and 21. Prior art patents may show in their embodiments just the equivalent capacitance of capacitors 18 and 19. However, it is clear from FIG. 1, that capacitances 20 and 21 are formed as soon as foils 8 and 9 are interleaved by rolling the combination into a coil. In this description, all capacitances formed by foils 8 and 9 are considered and it is conceded that the prior art patents have established four capacitances between foils 8 and 9 as shown in FIG. 2.

At a given instant, the current will flow into terminal 16 and out of terminal 17. It is clear from Kirchhoff's law that one-half of the current into the capacitive circuit at terminal 16 will be transferred by capacitances 18 and 20. The remaining current will be transferred by capacitances 19 and 21. Sections 10 and 14 must be able to accommodate the total current into terminal 16, whereas sections 11 and 13 need only be able to carry one-half of the current into terminal 16. The prior art has made an economical use of the foil material by making sections 10 and 14 of a larger cross-sectional area than sections 11 and 13.

FIG. 3 shows a basic form of the preferred embodiment of the present invention. The capacitive inductive winding has two terminals 36 and 37 which are each connected to a foil 33, 34, respectively. Each foil is divided into two sections. Foil 33 is illustrated by the section markings whereas foil 34 is illustrated by the symbol of elevation for metals. Terminal 36 is connected to two branch sections 25 and 26 which are in parallel with one another. The branch sections 25 and 26 of foil 33 are connected to a section 29 at a connection point 31. Sections 25, 26 and 29 are the constituents of foil 33. Terminal 37 is connected to parallel branches 27 and 28. These branch sections are connected to another section 30 with a jumper 32. Sections 27, 28 and 30 form the foil 34. FIG. 3 shows that branches 25 and 26 are interwoven with branches 27 and 28. The branch sections 25-28 are also separated by dielectric sheets, not shown for clarity, to increase the capacitance. Since additional foil was required to adequately accommodate the higher current flow in these sections, parallel foils are used instead of a single thick foil. The branches are interwoven to take advantage of the increased surface area associated with the required increased cross-sectional area.

FIG. 4 shows a schematic diagram of the capacitive inductive winding shown in FIG. 3. In this diagram, the branch sections 25, 26, 27 and 28 and the sections 29 and 30 are shown as coils to indicate their inductive property. Capacitances 38 and 39 are formed by interweaving branches 25, 27, 26 and 28. Capacitance 40 is formed by sections 29 and 30. When this combination is rolled into a form of a coil, foils 33 and 34 are interleaved and capacitances 41, 42 and 43 appear in a manner similar to capacitances 20 and 21 in FIG. 2. The invention in FIG. 4 has established six capacitances whereas the prior art winding in FIG. 2 has established only four capacitances. The additional capacitances are obtained by branching parallel sections of thin foils instead of using a single thick foil as in the prior art.

This capacitance inductive winding shown in FIGS. 3 and 4, not only has a nearly uniform current density through the foils, as did the prior art winding shown in FIG. 1, but it also has an increased capacitance using the same quantity of foil. This invention takes advantage of the fact that a larger cross-sectional area is required at one end of a foil than at the other end. The invention utilizes the larger cross-sectional area required at one end of the foil to produce a larger surface area at that end of the foil. This larger surface area will greatly increase the capacitance of the winding without a material increase in conductor costs. Therefore, the invention lies in the effective use of the additional foil required for the higher current at the terminals of the foils.

The winding shown in FIG. 3 has several possible applications. First of all, the winding can be used as a passive device such as a ballast. As a passive device, terminals 36 and 37 become energizing terminals and receive power from an external source. Secondly, the winding can be used as an active device when placed within a varying magnetic field. Under these conditions, terminals 36 and 37 become output terminals to deliver power to an external load. Thus, the winding can form part of a voltage or wattage regulator. The winding can also be used in a ferro-resonant transformer by connecting terminals 36 and 37 by a jumper. In this case, current circulates within the winding limited by the capacitive reactance of capacitances 38-43.

FIG. 5 shows a capacitive inductive winding of the prior art having two foils 49 and 50 and being composed of six sections. Sections 51 and 52 are heavy conductors as illustrated by the three coils in parallel. Sections 55 and 56 are composed of light conductors as illustrated by the single coil. Sections 53 and 54 are of intermediate thickness and are illustrated by two coils connected in parallel. Section 51 of foil 49 is connected to terminal 58 of the load 57 and section 52 of foil 50 is connected to load terminal 59. Sections 51 and 56 lie adjacent each other, sections 53 and 54 lie adjacent each other and sections 55 and 52 lie adjacent each other. Capacitor 60 illustrates the capacitance established between sections 51 and 56. This capacitor represents both the capacitance formed when sections 51 and 56 lie in parallel planes separated by a dielectric and the capacitance that is formed when the foils are interleaved by rolling the layers into a coil. Capacitor 61 illustrates the total capacitance established between sections 53 and 54. Similarly, capacitor 62 illustrates the total capacitance established between sections 52 and 55.

At a given instant, the current in the circuit flows in a clockwise direction as illustrated by the arrow. At this instant, a voltage V_L will be found across the load. This voltage is produced by the induced voltages across each of the six sections from a primary winding, not shown, due to the action of the magnetic core 63. Since each of the sections are of the same number of turns, each section produces V_i volts. Therefore, the potentials at voltage points 64, 65 and 66 will be V_i , $2V_i$ and $3V_i$, respectively. The potential at voltage point 67 is V_L volts since there is a direct connection between voltage point 67 and load terminal 59. The potential at voltage point 68 will then be $V_L - V_i$. Similarly, the potentials at voltage points 69 and 70 will be $V_L - 2V_i$ and $V_L - 3V_i$, respectively. The potential across capacitors 60, 61 and 62 is uniform having a value of $3V_i - V_L$. Since the values of capacitors 60, 61 and 62 are the same, the amount of current transferred through capacitors 60, 61 and 62 is identical.

FIG. 6 shows a winding with two foils 78 and 79 which incorporates the present invention. Each foil consists of three sections. Sections 71 and 72 represent heavy conductors which are composed of branch coils connected in parallel. Sections 73 and 74 represent intermediate conductors having only two branch coils per section. Sections 75 and 76 have only one coil and represent light conductors.

There are three differences between the invention shown in FIG. 6 and the prior art of FIG. 5. First, the

heavy conductor sections 71 and 72 lie adjacent to each other. The second difference is the presence of dielectrics, not shown, between each of the branch coils. The third difference lies in the fact that the branch coils are interwoven as well as being interleaved. Section 72 is directly connected to load terminal 83 and section 71 is connected to load terminal 84. In contrast to FIG. 5, the branch coils of sections 71 and 72 are interwoven, as in FIG. 4, but not shown for sake of simplicity in FIG. 6, establishing the capacitances 86, 87 and 88. The branch coils of sections 73 and 74 are likewise interwoven establishing two capacitances illustrated as capacitances 89 and 90. Sections 75 and 76 only establish a single capacitance 91 in a similar manner to the single capacitances 60, 61 and 62 in FIG. 5. If the capacitance 60 established between sections 51 and 56 of FIG. 5 is given a value of C , then the capacitances established between sections 53-54 and 55-52 of FIG. 5 and sections 75-76 of FIG. 6, all have the same capacitance value of C . The capacitance established between sections 73-74 in FIG. 6 has a value of $2C$, because the surface area with dielectric therebetween is twice as large. Finally, the capacitance established between sections 71-72 of FIG. 6 has a value of $3C$. There is a total capacitance of $6C$ in FIG. 6 whereas the total capacitance of the prior art winding in FIG. 5 is only $3C$.

At a given instant, current through the circuit will flow in a clockwise direction as indicated by the arrow. At that instant, the voltage found across the load is V_L . The voltages at terminal 84 and 83 will be zero and V_L , respectively. Each of the sections in FIG. 6 is assumed to have the same number of turns and will, therefore, have the same voltage induced when acted upon by a changing flux in a magnetic core 63. The potentials at voltage points 95, 96 and 97 will be V_L , $2V_L$ and $3V_L$. The potential at voltage point 98 is V_L since it is directly connected to terminal 83 of the load. Voltage terminals 99 and 100 will be at a potential of $V_L - V_L$. Voltage terminals 101 and 102 will be at a potential of $V_L - 2V_L$ and voltage terminal 103 will be at a potential of $V_L - 3V_L$. Whereas the six sections in Fig. 5 produced three uniform capacitances each having the same voltage across the capacitances, the six sections in FIG. 6 produce three unequal groups of capacitances each having different voltages across them. The voltage across capacitances 86, 87 and 88 is lower in value than the voltage across capacitances 89, 90 and 91. Consequently, a thinner dielectric can be used to separate the interweaved sections 71-72. The reduction in dielectric thickness increases the capacitance of section 71-72. The voltage across capacitances 89 and 90 is a lower value than the voltage across capacitance 91. The dielectric thickness in sections 73-74 can be reduced to increase the capacitance of this section. Therefore, sections 71-72 will have three times the capacitive area as sections 75-76 and the lowest potential difference and the thinnest dielectric of any of the section pairs. Sections 73-74 will have twice the capacitive area of sections 75-76. The voltage and the dielectric thickness of sections 73-74 will be greater than sections 71-72 but less than sections 75-76. Section 75-76 has the lowest surface area, the highest voltage and the thickest dielectric. The result is a capacitive inductive winding with a higher volt-ampere

capacity than the prior art winding shown in FIG. 5. The current transferred from each of sections 71, 73 and 75 of foil 78 is not uniform as was the case in the winding shown in FIG. 5. However, the progression of three parallel coils in section 71 to two parallel coils in section 73 to a single coil in section 75 with the proper dielectric thickness in each section, results in a good approximation for input cross-sectional area to yield a substantially uniform input current density. The uniform input current density was the objective of the prior art capacitive inductor winding shown in FIG. 5. The invention shown in FIG. 6, yields a substantially uniform input current density in addition to having an increase in capacitance and volt-ampere capacity.

FIG. 7 shows an extension of the principle or the invention shown in FIG. 4. The winding consists of two foils 151 and 152 which are each divided into (S) sections. Foil 151 has (S) odd number integer sections whereas foil 152 has (S) even number interger sections.

At a given instant, current will flow into terminal 153 and out of terminal 154. Sections (1) and (2) must be capable of accommodating all the current flow through terminal 153. Therefore, sections (1) and (2) are composed of (S) parallel coils. Since sections (1) and (2) are capacitively coupled as illustrated by capacitor 155, a portion of the current into section (1) is transferred into section (2). In order to have a similar value of input current density into sections (3) and (4) as the input current density into sections (1) and (2), sections (3) and (4) require only $(S-1)$ parallel coils. Again a portion of the input current is transferred from section (3) to section (4) through capacitance 156. Since the current is again reduced, sections (5) and (6) require only $(S-2)$ parallel coils. The series continues in a similar manner as shown by the dotted lines 168 and 169 until only one coil remains as shown in sections (2S-1) and (2S). The sections in FIG. 7 having an equal number of parallel coils are interwoven as shown in FIG. 4, but represented by capacitances 155, 156, 157 and 158 for simplicity. Foils 151 and 152 are still interleaved when the foils are rolled into a coil.

Assuming that each parallel coil has the same cross-sectional area, the current density to the input of each section can be made substantially the same by the proper selection of dielectric thickness. Thus, the dielectric 171A will be the thinnest between the parallel coils of sections (1) and (2). A thicker dielectric 171B must be used between sections (3) and (4), and additional thickness dielectric 171C must be used between sections (5) and (6). The thickest dielectric 171E will be required between the final sections 2S and a nearly as thick dielectric 171D between sections (2S-1). When a capacitive inductive winding is produced in this manner, a substantial increase in capacitance is achieved over the prior art method of winding using the same quantity of foil.

The progression of parallel coils shown in FIGS. 4, 6, and 7 is not the only possible configuration in which parallel coils can be connected. FIG. 8 shows a winding having five parallel coils in the first end sections 178 and 179 and a single coil in the second end sections 180 and 181. Many additional configurations are possible by adjusting the dielectric in each section pair. This adjustment of the dielectric is not limited to changes in dielectric thickness alone. The use of different types of

dielectrics with different dielectric constants within the same winding is equally applicable to this invention. The various possible parallel coil sequences, changes in dielectric thickness, and a plurality of types of dielectrics used within a winding are all within the scope of this invention.

The variation in dielectric constant K , the dielectric thickness D and variation in the area A , to achieve a graded capacitance, follows the textbook formula for capacitance $C = KA/D$.

FIG. 8 is a schematic diagram of a constant wattage transformer circuit which incorporates the present invention. The circuit is suitable for starting and operating gaseous discharge devices with negative resistance. These discharge devices such as fluorescent lamps, mercury vapor lamps, and sodium vapor lamps, require substantially higher starting voltage than operating voltage. Discharge devices have a high impedance before starting and require a high voltage for ionization. After being ionized, the impedance of these devices drops to a very low value.

In the transformer circuit shown in FIG. 8, a magnetic flux is induced into a core 175 by action of a primary winding 177. A magnetic shunt 176 permits the secondary voltage to be high at open circuit and yet drop to a low value under normal operating conditions. The magnetic flux in the core 175 induces voltage into a first and a second foil 194 and 195, respectively. The first foil 194 is composed of sections 178 and 180 and the second foil 195 is composed of sections 179 and 181. A capacitance as illustrated by capacitor 190 is established between sections 178 and 179. The parallel coils of sections 178 and 179 are interwoven as in FIG. 4, but are shown separated for the sake of simplicity in FIG. 8. Capacitance 190 represents the total capacitance established between sections 178 and 179. Similarly, capacitor 191 represents the capacitance established between sections 180 and 181. The dielectric is the thinnest between sections 178 and 179 and the thickest between sections 180 and 181. The first section 178 is connected through a terminal 183 to a load terminal 203 of a load 200. The second end section 180 of the first foil 194 is connected in series with the first end section 178. The second end section 181 is wound in series with a first end section 179. The first end section 179 is connected through a terminal 182 to a second load terminal 202.

Assuming the load to be a negative resistance device requiring a high starting voltage, the initial impedance of the load will be very high. Therefore, the impedance between terminals 182 and 183 will be essentially an open circuit. Under open circuit conditions, the induced voltages of the first foil 194 and the second foil 195 will circulate current through capacitors 190 and 191. The open circuit voltage that appears across terminals 182 and 183 will be the sum of the induced voltage of sections 178 and the voltage developed across capacitor 190 due to the aforesaid circulating current. This voltage ignites the device. After ignition, the impedance of the device is reduced and current to operate the device flows between terminals 182 and 183. The voltage across terminals 182 and 183 is reduced from the open circuit value to an operating value. Current continues to circulate through capacitors 190 and 191 in accordance with Kirchhoff's Laws.

The amount of current circulating during operation is different than the amount of current circulating during open circuit conditions. This is caused by the change in voltage across capacitors 190 and 191.

The voltages of the circuit shown in FIG. 8 occur in a manner similar to the voltages shown in FIG. 6. The voltage between the first end sections 178 and 179 is less than the voltage between the second end sections. Therefore, a thinner dielectric can be used between sections 178 and 179 than can be used between sections 180 and 181. The thinner dielectric increases the capacitance between the first end sections 178 and 179. The capacitance of the winding in FIG. 8 has been increased over a prior art winding by the process of interweaving parallel coils and using thinner dielectrics between the parallel coils in the first end sections 178 and 179.

The invention as disclosed in this specification accomplishes the objectives set forth for an improved capacitive inductive winding and advances the art of construction of these windings. Combining the concepts of parallel interwoven coils to replace a single thick foil and the concept of changing dielectrics or dielectric thickness, produces a capacitive inductive winding having a nearly uniform current density to each section of the foils. In addition, the winding has an increased capacitance and volt-ampere capacity over the prior art windings using the same quantity of foil. A winding constructed in accordance with this invention is less in weight and size than a prior art winding of identical volt-ampere capacity. The nearly uniform current density within the foils produces a nearly uniform internal heat production and reduces heat gradients within the winding. Either one of the two concepts of parallel interwoven coils or changing the dielectric or dielectric thickness can be used independently of one another. Depending upon the application of the capacitive inductive winding, one or both of the concepts can be used to improve a winding over that of the prior art. However, the winding obtains the acme of refinement when both parallel interwoven coils and changing dielectric or dielectric thickness are used simultaneously.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of the circuit and the combination and arrangement of circuit elements may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A capacitive inductive winding, comprising in combination,
 - first and second foil means each having first and second end sections,
 - means establishing a larger current carrying ability at said first end sections than at said second end sections of each of said first and second foil means,
 - and graded capacitance means establishing a larger capacitance between said first end sections of said first and second foil means than between said second end sections of said foil means.
2. A capacitive inductive winding as set forth in claim 1, wherein current at a given instant flows into

said first end section of said first foil means and flows out of said first end section of said second foil means.

3. A capacitive inductive winding as set forth in claim 1, wherein said means establishing a larger current carrying ability at said first end sections than at said second end sections includes a larger cross-sectional area at said first end sections than at said second end sections.

4. A capacitive inductive winding as set forth in claim 1, wherein said graded capacitance means includes means establishing a larger effective surface area at said first end sections than at said second end sections.

5. A capacitive inductive winding as set forth in claim 1, wherein said first and second foil means are interleaved when said foils are rolled into a winding.

6. A capacitive inductive winding as set forth in claim 1, wherein said first and second foil means are separated by dielectric means.

7. A capacitive inductive winding as set forth in claim 1, wherein each of said first and second foil means has only three sections.

8. A capacitive inductive winding as set forth in claim 1, wherein said first and second foil means are each composed of a plurality of series sections.

9. A capacitive inductive winding as set forth in claim 1, wherein said foil means has a total of $2S$ sections and wherein S is any positive integer,

said first foil means composed of S odd numbered integer sections,

said second foil means composed of S even numbered integer sections,

said odd and even numbered integer sections one and two having S coils connected in parallel and being said first end sections of said first and second foil means, respectively,

said odd and even numbered integer sections three and four having $(S-1)$ coils connected in parallel, the odd numbered integer sections being defined by the expression $(2N-1)$ having $(S+1-N)$ coils connected in parallel where N is a positive integer not greater than S ,

the even numbered integer sections being defined by the expression $(2N)$ having $(S+1-N)$ coils connected in parallel,

said odd numbered integer section $(2S-1)$ having a coil and being said second end section of said first foil,

said even numbered integer sections $(2S)$ having a coil and being said second end section of said second foil,

and said graded capacitance means includes interwoven sections having an equal number of coils connected in parallel and having said first and second foil means interleaved.

10. A capacitive inductive winding as set forth in claim 4, wherein said means establishing a larger effective surface area includes said first end sections being composed of only two coils connected in parallel.

11. A capacitive inductive winding as set forth in claim 4, wherein said graded capacitance means includes interwoven coils and interleaved foils.

12. A capacitive inductive winding as set forth in claim 6, wherein said graded capacitance means includes means increasing the ratio of K/D where K is

the dielectric constant and D is the thickness of said dielectric means.

13. A capacitive inductive winding as set forth in claim 6, wherein said graded capacitance means includes means increasing the ratio of K/D , where K is the dielectric constant and D is the thickness of said dielectric means and means establishing a larger effective surface area A .

14. A capacitive inductive winding as set forth in claim 6, wherein said graded capacitance means includes means establishing a larger effective surface area and means changing said dielectric means.

15. A capacitive inductive winding as set forth in claim 8, wherein said first and second foil means are composed of coils connected in parallel.

16. A capacitive inductive winding as set forth in claim 8, including means producing a variable magnetic flux, and

said first and second foil means being located within said varying magnetic flux to induce a voltage into said foil means.

17. A capacitive inductive winding as set forth in claim 14, wherein said means establishing a larger effective surface area includes sections composed of coils connected in parallel,

and said means changing said dielectric means includes a thinner dielectric means separating said first end sections than separating said second end sections.

18. A capacitive inductive winding as set forth in claim 17, wherein the number of said parallel coils is related to the thickness of said dielectric means to establish substantially uniform current density to the input to said sections.

19. A capacitive inductive winding as set forth in claim 18, wherein each of said coils has substantially the same cross-sectional area.

20. A capacitive inductive winding as set forth in claim 16, including a first and a second load terminal, means connecting said first load terminal to said first end section of said first foil means, and means connecting said second load terminal to said first end section of said second foil means.

21. A capacitive inductive winding as set forth in claim 16, wherein said means producing a varying magnetic flux includes a primary winding and a magnetic core.

22. A capacitive inductive winding as set forth in claim 6, wherein the voltage between said first end sections is less than the voltage between said second end sections and the thickness of said dielectric means is less at said first end sections than at said second end sections.

23. A capacitive inductive winding, comprising in combination,

first and second foil means each having first and second end sections,

dielectric means separating said first and second foil means,

graded capacitance means establishing a larger capacitance between said first end sections of said first and second foil means than at said second end sections of said foil means,

and said graded capacitance means including a change in said dielectric means at said first end

11

sections relative to said dielectric means at said second end sections.

24. A capacitive inductive winding as set forth in claim 23, wherein said changed dielectric means includes means increasing the ratio of dielectric constant to thickness of said dielectric means.

25. A capacitive inductive winding as set forth in claim 23, wherein said changed dielectric means includes a thinner dielectric means separating said first end sections than separating said second end sections.

26. A capacitive inductive winding as set forth in

12

claim 23, wherein said changed dielectric means includes means increasing the dielectric constant of said dielectric means.

27. A capacitive inductive winding as set forth in claim 25, wherein the voltage between said first end sections is less than the voltage between said second end sections.

28. A capacitive inductive winding as set forth in claim 1, wherein said first end sections of said first and second foil means are adjacent to one another.

* * * * *

15

20

25

30

35

40

45

50

55

60

65