June 18, 1968 R. P. MILLER ET AL 3,389,302

ELECTRICAL INDUCTIVE APPARATUS

Filed Oct. 21, 1965 2 Sheets-Sheet 1

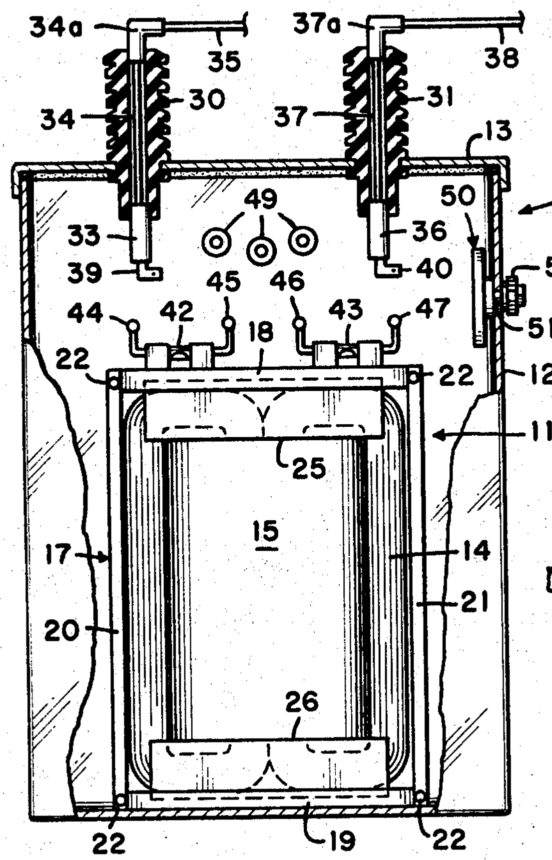

FIG. 1

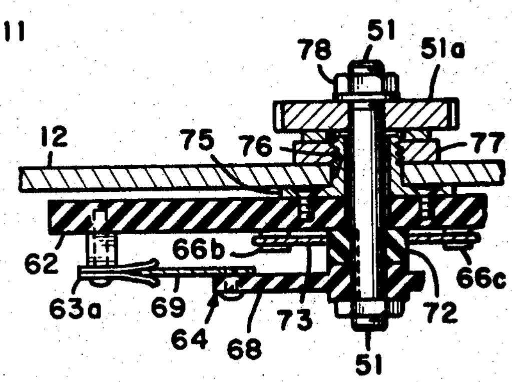

FIG. 3

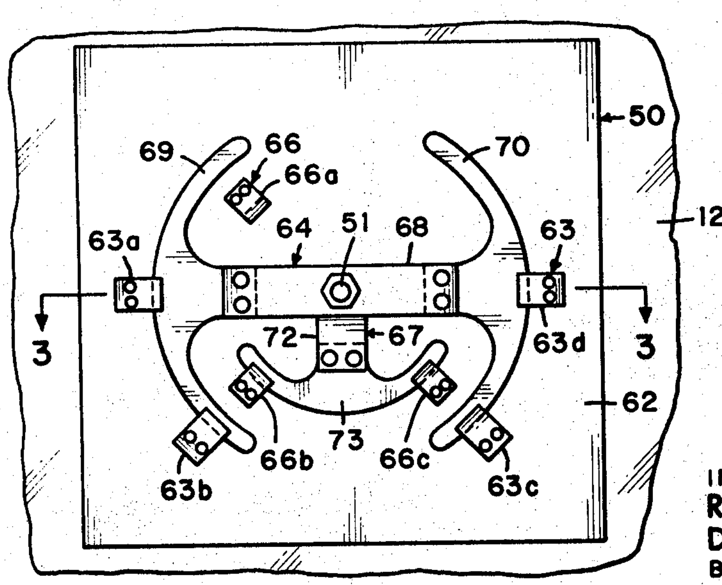

FIG. 2

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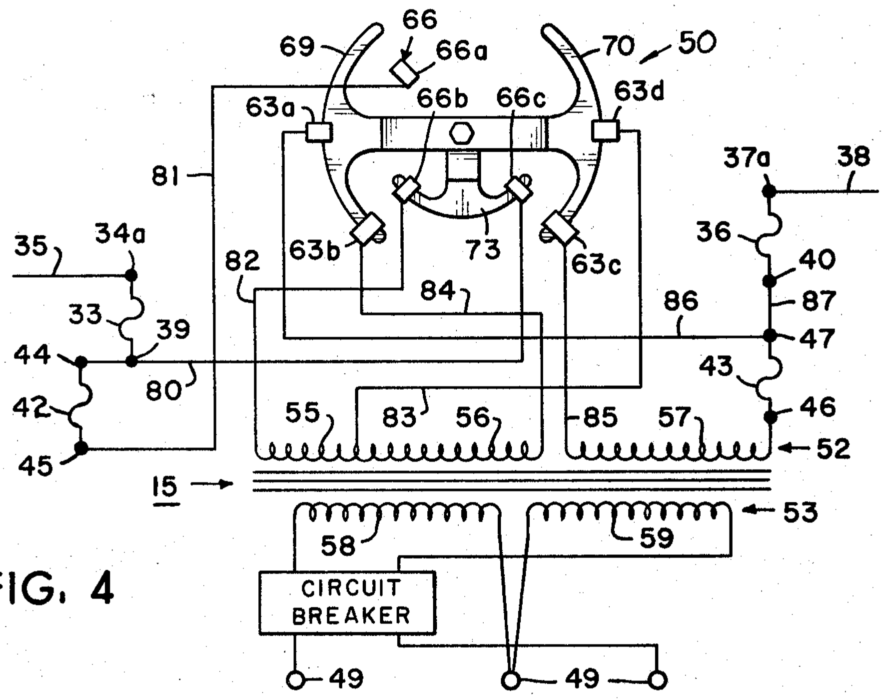

FIG. 4

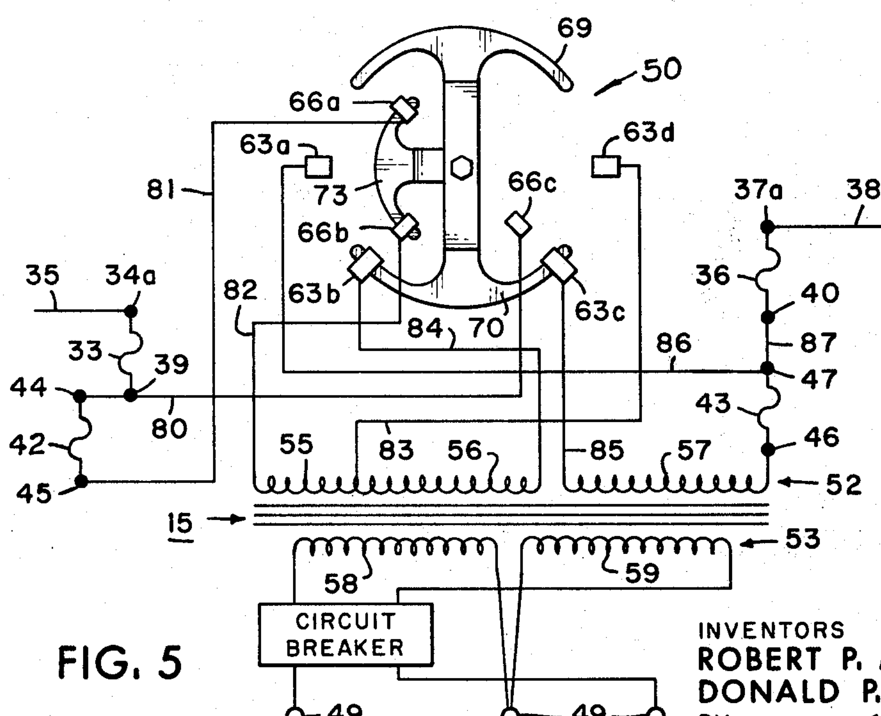

FIG. 5

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United States Patent Office

3,389,302

Patented June 18, 1968

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3,389,302

ELECTRICAL INDUCTIVE APPARATUS

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Filed Oct. 21, 1965, Ser. No. 499,232
19 Claims. (Cl. 317—15)

ABSTRACT OF THE DISCLOSURE

A transformer operable on different supply voltages having switch means to selectively connect the primary in a first winding arrangement in which a first section is connected in series with fuse means and parallel-connected sections, said first section having a different number of turns than the other sections, and a second winding arrangement in which all of the sections are in series with each other and other fuse means, all turns of the primary being conductive in both of the arrangements, the fuse means effective on the first winding arrangement being maintained in the circuit in the second winding arrangement.

This invention relates to electrical inductive apparatus and more particularly to electrical inductive apparatus, such as transformers, having circuit protective means associated therewith.

Distribution transformers connected in an electrical distribution system are often provided with protective circuit interrupting means or fuses in the primary winding circuit within the transformer casing and, in many cases, with fuses or circuit breakers in the low voltage secondary winding or load circuit of the transformer. As is well known, distribution transformers having primary windings adapted for connection with two high voltage distribution supply lines, such as when the system is supplied power from a delta connected power source, two primary bushings are used and a fuse is connected at each end of the primary winding so that both ends of the primary will be disconnected from the system upon the occurrence of a fault therein. The size or rating of the primary winding fuses must be coordinated with the secondary winding circuit breakers, if used, and the line fuses or protective circuit interrupting means at the substation or high voltage supply transformer that supplies the power to all of the distribution transformers connected to the supply lines of the distribution system. The primary winding fuses and secondary circuit breakers, if used, are correlated such that, upon an overload condition, the circuit breakers will disconnect the load quickly enough to prevent the primary fuses from disconnecting the primary winding from the supply line; and this avoids the necessity of replacing primary fuses as a result of excessive loading. The primary fuses are also selected such that, upon the occurrence of a fault or excessive current in the primary of the distribution transformer, the primary fuses will disconnect the primary winding from the supply line quickly enough to prevent the line fuses or circuit interrupting means at the substation transformer from disconnecting the entire distribution system from the substation transformer. In this way, a fault in one distribution transformer will result in only that transformer being taken off the line as opposed to having all of the distribution transformers taken off the line.

Because the line losses increase and the system regulation becomes poorer as the load requirements on the distribution system increase, electric power companies often require distribution transformers equipped with means for changing the transformation ratio thereof, such as by

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means of a tap changing switch, so that the supply voltage can be raised to reduce the line losses and improve the system regulation when desired. However, if the primary fuses are designed to provide optimum protection when the transformer is connected for operation at one supply voltage, the same primary fuses would not provide optimum protection when the transformer is connected for operation on the higher supply voltage. If the primary fuses are selected on the basis of a compromise, that is, selected so as to operate on both the lower and higher supply voltages in order to avoid the above-mentioned changing of fuses, then optimum circuit protection is not obtained when the transformer is connected for operation on the higher supply voltage or on the lower supply voltage. It is, therefore, desirable to utilize primary fuses that are selected to provide optimum circuit interrupting characteristics when the primary winding is adapted for operation on the lower supply voltage and other fuses selected to provide optimum circuit interrupting characteristics when the primary winding is connected for operation on the higher supply voltage.

When the higher supply voltage value is a whole number multiple of the lower supply voltage value, the primary winding can be arranged in like winding sections that are changed or switched from parallel relationship to series relationship when the supply voltage is to be changed from the lower supply voltage value to the higher supply voltage value. In such an arrangement, the (higher current rated) fuses selected for operation on the lower supply voltage (higher current) may be connected to remain in the primary circuit for both the series and parallel winding connection to provide optimum circuit interrupting characteristics when the transformer is connected for operation on the lower supply voltage, these fuses being essentially ineffective on the higher voltage (lower current) connection. Those fuses (lower current rated) that are selected to provide optimum circuit interrupting characteristics when the transformer is connected for operation on the higher supply voltage (lower current) are connected in series with the entire primary winding during transformer operation on the higher supply voltage but may be arranged to also be in the primary circuit when the transformer is connected for operation on the lower supply voltage; however, they must, of course, be connected in series with only a portion or section of the primary winding so that they do not carry the total primary current when the transformer is operating on the lower supply voltage.

When the ratio of the higher to the lower supply voltages is not an integer, that is, when one of the supply voltage values is not a whole number multiple of the other, the primary winding may be arranged in winding sections connected in parallel relation with each other when connected for operation on the lower supply voltage. When the transformer is to be operated on a higher supply voltage, the winding sections can be arranged such that only a portion of one winding section is connected in series with another winding section or sections in order to obtain the required turns ratio necessary for operating the transformer on the higher voltage. For the above lower supply voltage winding connection, the effective fuses (higher current rated) are connected in series with the parallel connected winding sections and the lower current rated fuses may be each connected respectively in series with only one of the parallel connected winding sections. For the above higher supply voltage connection, the lower current rated fuses are connected in series with the effective portions of the primary winding and the higher current rated fuses, although they may be retained in the primary circuit, do not perform the basic circuit interrupting function. However, such a winding arrangement has the disadvantage of having an idle or inactive winding portion when the primary is connected for the higher supply voltage operation, that is, a portion of one winding section does not carry primary current. In such a case, upon the occurrence of a surge voltage, such as caused by lightning, the winding section having the idle portion acts like an autotransformer, and very high voltages may appear across the idle portion of the winding with the danger of an insulation breakdown or short. The greater the idle winding portion, the greater will be the danger of damage to the transformer.

It is, therefore, an object of the present invention to provide an improved electrical inductive apparatus wherein the above-mentioned disadvantages are substantially obviated.

Another object of the present invention is to provide electrical inductive apparatus having means for changing the connection of electrical windings thereof from one winding arrangement operable at a first voltage value to another winding arrangement operable at a second voltage value wherein circuit protective means are utilized that can be selected to provide substantially optimum protective circuit interrupting characteristics when the electrical windings are operating on either of the first and second voltage values.

Another object is to provide a transformer having a novel winding circuit with protective circuit interrupting means associated therewith and with relatively simple switch means for switching the winding circuit from a circuit arrangement which is operable on a first voltage to a second circuit arrangement operable on a second voltage where the ratio of the first and second voltages is not a whole number, wherein the circuit interrupting means used can be selected to provide substantially optimum circuit interrupting characteristics when the winding circuit is operating on the first voltage and when it is operating on the second voltage and wherein neither of the first and second winding arrangements require idle winding portions.

Another object is to provide a transformer of the above-mentioned type which is disposed in a transformer tank and wherein the above-mentioned switching means is operable to effect the switching of the winding circuit from the first circuit arrangement to the second circuit arrangement as a result of the movement of a single switch actuator accessible from outside the transformer tank.

Still another object is to provide a transformer having novel circuit means for changing the transformation ratio thereof so that the transformer primary winding is selectively operable on either a first or a second supply voltage value where the supply voltage values are in a ratio that is not a whole number, wherein protective circuit interrupting means are utilized which can be selected to provide optimum circuit interrupting characteristics when the transformer is operating on either of the supply voltage values, the entire primary winding is conductively connected in the primary circuit of the transformer when it is operating on either the supply voltage values, and with a minimum of winding connections.

These and other objects and advantages will become more apparent from the foregoing description and accompanying drawings.

In the drawings which illustrate preferred embodiments of the present invention,

FIG. 1 is an elevational view partly in section of a distribution transformer embodying the present invention but with certain conductive leads deleted for simplicity's sake,

FIG. 2 is an elevational view of the switch means of FIG. 1,

FIG. 3 is a sectional view of the switch means taken along the line 3—3 of FIG. 2,

FIG. 4 is a schematic diagram of the transformer of FIG. 1 with the windings thereof connected to provide a predetermined transformation ratio, and

FIG. 5 is a schematic diagram of the transformer of FIG. 1 with the windings thereof connected to provide a different transformation ratio.

Referring now to FIG. 1 of the drawings, a distribution transformer **10** is shown which includes a transformer core and coil assembly **11** disposed within a transformer casing or tank **12** having a cover **13**, the casing **12** being adapted to be substantially filled with a suitable dielectric, such as transformer oil (not shown). The core and coil assembly **11** includes a three-legged magnetic core **14**, a plurality of coils **15** surrounding the middle core leg, and a frame **17**. The frame **17** includes upper and lower end plates **18** and **19**, opposed side plates **20** and **21** interconnected, such as by bolts **22**, two upper spacer blocks **25** (one in view) at opposite sides of the core between the upper end of coils **15** and end plate **18**, and a pair of lower spacer blocks **26** (one in view) at opposite sides of the core between the coil **15** and lower end plate **19**. The coils **15** and core **14** are firmly held in fixed relationship by the plates **18–21** and blocks **25** and **26**.

A pair of spaced primary bushings **30** and **31** of insulating material, such as porcelain, extend through and are connected to the cover **13**. A primary fuse **33** extends into the lower end of bushing **30** and has an upper terminal end threadedly and conductively connected to the lower end of a bushing conductor **34** having an upper terminal end **34***a* adapted for connection to a high voltage supply line **35**. Similarly, a primary fuse **36** extends into the lower end of bushing **31** and has an upper terminal end threadedly and conductively connected to the lower end of a bushing conductor **37** which has an upper terminal end **37***a* connected to another high voltage supply line **38**. Power lines **35** and **38** may be one phase of a three-phase power supply or substation high voltage transformer (not shown) which has a secondary connected in delta and a primary in Y. The fuses **33** and **36** have lower end terminals **39** and **40**, respectively, and each provides a conductive terminal. Another pair of primary fuses **42** and **43** are shown secured to the top of the upper end plate **18** of frame **17**. Fuse **42** has a pair of end terminals **44** and **45** and fuse **43** has a pair of end terminals **46** and **47**. Three secondary winding bushings **49** are shown connected to the wall of the casing **12** for connection to a load circuit, such as 120/240 volt load circuit. A ratio changing switch **50**, shown in detail in FIGS. 2 and 3, is mounted within casing **12** to the wall thereof and has an actuating shaft **51** extending through the casing wall and a manually rotatable member **51***a* fixed thereto externally of the casing for operating the switch **50**.

As seen in FIGS. 4 and 5, the transformer coils **15** include a primary winding **52** and a secondary winding **53**. The primary winding **52** incluudes three winding sections **55**, **56** and **57**, and the secondary winding **53** includes a pair of like winding sections **58** and **59** adapted for connection with the secondary winding bushings **49**. A conventional secondary winding circuit breaker, which may also be mounted in the transformer casing **12**, is shown in block form connected in the secondary winding circuit to disconnect the secondary winding **53** from the load upon the occurrence of an overload condition. The switch **50**, which is described in detail hereinafter, is connected in the primary winding circuit and is operable to change the transformation ratio of the transformer **10** when it is desired to change the voltage of the power supply or substation transformer and therefore the voltage between power supply lines **35** and **38**.

Referring now FIGS. 2 and 3, the switch **50** includes an insulating panel **62** having a plurality of like stationary contacts **63** circumferentially arranged thereon, a movable contact member **64** connected to shaft **51** which is rotatable to selectively interconnect certain ones of the contacts **63**, a second plurality of like stationary contacts **66** predeterminately circumferentially arranged on panel **62**, and a second movable contact member **67** connected to shaft **51** which is rotatable to selectively interconnect certain ones of the contacts **66**. Contacts **63** and **66** are fixed to the panel **62**, such as by screws, with the contacts **63** and associated contact member **64** in planes spaced farther from panel **62** than the planes of contacts **66** and associated contact member **67**. The contacts **63** are sequentially identified as contact **63**_a_ and **63**_d_, and the contacts **66** are sequentially identified as contacts **66**_a_ through **66**_c_.

Movable contact member **64** includes an insulating member **68** keyed to shaft **51** and arcuate metal contacts **69** and **70** connected, such as by screws, to the opposite ends of member **68**. Each of the contacts **69** and **70**, when in an operable position, electrically interconnects two successive stationary contacts **63**.

The movable contact member **67** includes an insulating member **72** keyed to the shaft **51** and an arcuate metal contact **73** connected to the insulating member, such as by screws. The contact **73**, when in an operable position, electrically interconnects two successive stationary contacts **66**.

The panel **62** is fixed, such as by screws, to a collar member **75** (FIG. 3) that extends through an opening **76** in the wall of casing **12** and which receives a nut **77** on the external end thereof for securing the switch **50** to the casing **12**. The manually rotatable member **51**_a_ is keyed to the external end of shaft **51** and secured thereto by a nut **78**.

Referring now to FIGS. 4 and 5, supply line **35** is connected to bushing terminal **34**_a_ which, in turn, is connected to fuse **33** within the bushing **30**. The terminal **39** of fuse **33** is connected to terminal **44** of fuse **42** and to contact **66**_c_ of switch **50** by a lead **80**. The other terminal **45** of fuse **42** is connected to switch contact **66**_a_ by a lead **81**. The left end of primary winding section **55** is connected by a lead **82** to switch contact **66**_b_ and the right end of section **55** is connected to the left end of primary winding section **56** and to switch contact **63**_d_ by a lead **83**. The right end of section **56** is connected to switch contact **63**_b_ by a lead **84**. The left end of primary winding section **57** is connected by a lead **85** to switch contact **63**_c_ and the right end thereof to terminal **46** of fuse **43**. The other terminal **47** of fuse **43** is connected to switch contact **63**_a_ by a lead **86** and also to the terminal **40** of fuse **36** by a lead **87**. The fuse **36** is connected at the opposite end thereof to bushing terminal **37**_a_ to which supply lead **38** is connected.

With the switch **50** in the position shown in FIG. 4, contacts **66**_b_ and **66**_c_ are conductively interconnected by movable contact **73** to connect fuse **33** between bushing terminal **34**_a_ and the left end of winding section **55**. The right end of section **55** is connected to the left end of winding section **56** and also to the left end of winding section **57** since contacts **63**_c_ and **63**_d_ are interconnected by movable contact **70**. The right end of section **56** is connected to terminal **40** of fuse **36** since contacts **63**_a_ and **63**_b_ are interconnected by movable contact **69**. Thus, it is apparent from FIG. 4 that winding sections **56** and **57** are connected in parallel circuit relation with respect to each other and in series circuit relation with section **55** and fuses **33** and **36** to provide a predetermined transformation or turns ratio with the secondary winding **53** so as to provide the desired secondary winding voltage for a given supply voltage between supply lines **35** and **38**. For purposes of example, it will be assumed herein that when they supply voltage is 4800 volts switch **50** is in the position shown in FIG. 4 and the voltage across each of the secondary winding sections **58** and **59** is 120 volts.

With the switch **50** in the position shown in FIG. 5, contacts **66**_a_ and **66**_b_ are interconnected by movable contact **73** to connect fuse **42** between bushing terminal **34**_a_ and the left end of winding section **55**. The right end of section **55** is connected to the left end of section **56**, and the right end of section **56** is connected to the left end of section **57** since contacts **63**_b_ and **63**_c_ are interconnected by movable contact **70**. When switch **50** is in the position shown in FIG. 5, the winding sections **55**, **56** and **57** and fuses **42** and **43** are connected in series circuit relationship between the supply lines **35** and **38** to provide a different predetermined transformation or turns ratio with the secondary winding **53** so as to provide the desired secondary voltage for a different supply voltage. In this case, it will be assumed, for purpose of example, that with the switch in the position indicated in FIG. 5, the supply voltage is 7620 volts and the transformation ratio is such that each secondary winding section has 120 volts thereacross.

The fuses **33** and **36** can be selected to provide optimum circuit interrupting characteristics when the transformer is operating on the lower of the two operating voltages (4800 volts), the switch being in the position shown in FIG. 4. The fuses **42** and **43** can be selected to provide optimum circuit interrupting characteristics when the transformer is operating on the higher of the two operating voltages (7620 volts), the switch being in the position indicated in FIG. 5. Fuses **33** and **36** are selected to have a higher current rating than fuses **42** and **43** since fuses **33** and **36** are effective on the relatively lower supply voltage (higher primary current) while the fuses **42** and **43** are effective on the relatively higher supply voltage (lower primary current). Since the fuses **33** and **36** will normally have a higher current rating than that of fuses **42** and **43**, they may be conveniently permanently connected to the bushing terminals **34** and **37**, as shown, and in both positions of switch **50**, that is, when the transformer is operating on either of the two supply voltage values. Of course, when the switch is in the position shown in FIG. 5, the fuses **33** and **36** carry the primary current but do not provide effective circuit interrupting operations. Also, while the fuses **33** and **36** are the effective fuses when the switch is in the position shown in FIG. 4, fuse **43** may be permanently connected in series with winding section **57**, as shown in FIG. 4, as it will carry only the current of winding section **57** since it is connected in parallel with winding section **56**.

In general, when the ratio of the relatively high supply line voltage, E_1, to the relatively low supply voltage, E_2, is not an integer, the primary winding sections are determined by the following simultaneous equations:

$$V_1+NV_2=E_1 \quad (1)$$

$$V_1+V_2=E_2 \quad (2)$$

where V_1 is the voltage of the common series winding section, such as section **55**, V_2 is the voltage of each of the winding sections that are adapted for parallel connection when the supply voltage is E_2, and N is the number of winding sections adapted to be connected in parallel with each other and which is equal to the integer next above the ratio of E_1 to E_2.

In the example transformer, the higher supply line voltage E_1 is 7620 and the lower supply line voltage E_2 is 4800 so that the ratio of E_1 to E_2 is approximately 1.58; therefore, $N=2$ and there will be two winding sections conected in parallel and one in series with the two parallel connected sections. Thus, substituing the known values in Equations 1 and 2 results in:

$$V_1+2V_2=7620 \quad (1)$$

$$V_1+V_2=4800 \quad (2)$$

From these equations $V_1=1980$ and $V_2=2820$. Thus, primary winding section **55** is designed to have 1980 volts thereacross and each of the winding sections **56** and **57** is designed to have 2820 volts thereacross, the number of turns of these primary winding sections, of course, being in proportion to the designed voltage thereacross.

By arranging the primary winding into sections which include a plurality of like sections, such as sections **56** and **57**, connectable in parallel relation, and a series or common section, such as section **55**, and in accordance with the above simultaneous Equations 1 and 2, the necessity of having an undesirable idle winding portion is avoided even though the ratio of the supply line voltages is not an integer.

When the supply line voltage is at the lower value and the switch **50** is in the position shown in FIG. 4, the fuses **33** and **36** are effective to disconnect the primary winding **52** from the supply lines **35** and **38** upon the occurrence of a transformer fault, such as a short in the primary winding. Fuses **33** and **36** are selected so that they will interrupt current therethrough before the line fuses or circuit interrupting means at the substation can operate to interrupt power to the supply lines **35** and **38** and the other distribution transformers connected thereto. Similarly, when the switch **50** is in the position shown in FIG. 5 and the line voltage is at the relatively higher voltage, the fuses **42** and **43** will be effective to interrupt primary current before the substation circuit interrupting means can operate to interrupt power to the supply lines **35** and **38**. The effective fuses, being ahead of the primary winding or located at the ends of the primary winding, provide adequate protection for the line or substation circuit interrupting means.

With the hereinbefore described arrangement there are relatively few circuit lead connections and switch contacts required. Also, the ratio of transformer **10** can be easily and simply changed by rotating member **52** from outside the transformer casing **12** to change the switch **50** from the position shown in FIG. 4 to that shown in FIG. 5 when it is desired to increase the line voltage.

If desired, the fuse **43** may also be disconnected from winding **57** when the transformer is to be operated on the lower supply voltage by suitably switching it out of the primary circuit, such as by use of additional contacts (not shown) on switch **50**. Furthermore, if desired, the fuses **33** and **36** may be switched out of the primary circuit when the transformer is to be operated on the higher supply voltage by relocating them and providing suitable contacts on switch **50**.

From the foregoing, it is obvious that novel transformer means meeting the objects and advantages set forth hereinbefore, and others, are provided. It is to be understood that the foregoing description and the accompanying drawings have been given only by way of illustration and example, and that changes and alterations in the present disclosure, which will be readily apparent to one skilled in the art, are contemplated as within the scope of the present invention which is limited only by the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A transformer comprising a pair of transformer terminals, primary and secondary windings, said primary windings including first, second and third winding sections, first and second pairs of fuses, and switch means having first and second operating positions and connected to said winding sections and said fuses for changing the transformation ratio of said transformer, said switch means when in said first position interconnecting said first and second winding sections in parallel with each other and in series with said third winding section and said first pair of fuses between said transformer terminals to effect a first predetermined transformation ratio between said primary and secondary windings, said switch means when in said second position interconnecting said first, second and third sections and said second pair of fuses in series with each other between said transformer terminals to effect a second predetermined transformation ratio between said primary and secondary windings, one of said fuses of said first pair being connected between one of said transformer terminals and one end of said primary winding and the other of said fuses of said first pair being connected between the other of said transformer terminals and the opposite end of said primary winding when said switch is in said first position, one of said fuses of said second pair being connected between said one transformer terminal and said one end of said primary winding and the other of said fuses of said second pair being connected between said other transformer terminal and said opposite end of said primary winding when said switch is in said second position.

2. A transformer comprising a casing, a pair of primary bushings mounted to said casing each having a bushing conductor, said bushing conductors having first ends exterior of said casing for respective connection to a pair of power supply lines, a first pair of fuses having first ends thereof connected respectively to the ends of said bushing conductors opposite said first ends thereof, a core and coil assembly in said casing including a magnetic core, and primary and secondary widnings on said core, said primary winding including first and second equal winding sections and a third winding section, a second pair of fuses mounted to said core and coil assembly, and switch means mounted within said casing and including switch actuating means extending through said casing with a portion thereof exterior of said casing for actuating said switch means from a first position to a second position in response to predetermined movement of said exterior portion, means connecting said winding sections and said fuses to said switch means, said switch means when in said first position interconnecting said first and second winding sections in parallel with each other and in series with said third section between the ends of said first pair of fuses opposite said first ends thereof, said switch means when in said second position interconnecting all of said winding sections and said secind pair of fuses in series with each other between said opposite ends of said first pair of fuses.

3. A transformer comprising a casing, a pair of transformer terminals adapted to be supplied power from a source of supply voltage that is subject to being changed from a first voltage value to a second voltage value which is of higher value than said first voltage value and wherein said second voltage value divided by said first voltage value yields a quotient that is not an integer, primary and secondary windings in said casing, said primary windiing including first and second winding sections each having a like predetermined number of turns and a third winding section having a different predetermined number of turns than said first and second winding sections, first and second fuse means in said casing, and switch means having first and second operating positions and connected to said sections and said fuse means, said switch means being mounted within said casing and including switch actuating means extending through a wall of said casing with a portion thereof exterior to said casing whereby said switch means is movable between said operating positions in response to movement of said exterior portion, said switch means when in said first position interconnecting said first and second sections in parallel with each other and in series with said third section and said first fuse means between said transformer terminals to effect a predetermined transformation ratio between said primary and secondary windings so that said transformer is operable when said supply voltage is at said first voltage value, said switch means when in said second position interconnecting said first, second and third sections and said second fuse means in series with each other between said transformer terminals to effect another predetermined transformation ratio between said primary and secondary windings so that said transformer is operable when said supply voltage is at said second voltage value, all of said turns of said winding sections being conductive when said transformer is in operation and said supply voltage is at said first voltage value and also when said supply voltage is at said second voltage value.

4. A transformer comprising a casing, a pair of primary bushings mounted to said casing each having a bushing conductor, said conductors having first ends exterior of said casing for respective connection to a pair of power supply lines connected to a source of supply voltage that is subject to being changed from a first voltage value to a second voltage value which is of higher value than said first voltage value, a first pair of fuses having first ends thereof connected respectively to the ends of said bushing conductors opposite said first ends thereof, a core and coil assembly in said casing including a magnetic core, and primary and secondary windings on said core, said primary winding including first and second equal winding sections and a third winding section, a second pair of fuses mounted to said core and coil assembly, and switch means mounted within said casing and including switch actuating means extending through said casing with a portion thereof exterior of said casing for actuating said switch means from a first position to a second position in response to predetermined movement of said exterior portion, means connecting said winding sections and said fuses to said switch means, said switch means when in said first position interconnecting said first and second winding sections in parallel with each other and in series with said third section between the ends of said first pair of fuses opposite said first ends thereof to provide a predetermined transformation ratio between said primary and secondary windings so that said transformer is operable when said supply voltage is at said first voltage value, said switch means when in said second position interconnecting all of said winding sections and said second pair of fuses in series with each other between said opposite ends of said first pair of fuses to provide a predetermined transformation ratio between said primary and secondary windings so that said transformer is operable when said supply voltage is at said second voltage value.

5. A tranformer comprising a casing; a pair of primary bushings mounted to said casing and having bushing conductors for respective connection to a pair of power supply lines; a coil and core assembly mounted within said casing and including a magnetic core and primary and secondary windings on said magnetic core; said primary winding including first and second equal winding sections and a third winding section; a switch mounted within said casing including first, second, third, fourth, fifth, sixth and seventh stationary contacts, movable contact means engageable with said stationary contacts and having first and second operable positions, said movable contact means including first, second and third contact members, and actuating means connected with said movable contact means and extending through said casing with a portion thereof exterior of said casing for moving said movable contact means from one of said operable positions to the other of said positions in response to predetermined movement of said exterior portion; first and second pairs of fuses; means connecting one end of one of said fuses of said first pair to one of said bushing conductors and the other end thereof to a first circuit point; means connecting one end of the other fuse of said first pair to the other of said bushing conductors and the other end thereof to a second circuit point; means connecting one end of one of said fuses of said second pair to said first circuit point and the other end thereof to said first contact; means connecting one end of the other fuse of said second pair to said second circuit point and the other end thereof to one end of said first section; means connecting said first circuit point to said second contact; means connecting one end of said third section to said third contact; means connecting the other end of said third section and one end of said second section to a third circuit point; means connecting said third circuit point to said fourth contact; means connecting the other end of said second section to said fifth contact; means connecting the other end of said first section to said sixth contact; and means connecting said second circuit point to said seventh contact; said first contact member being in engagement with and interconnecting said second and third contacts, said second contact member being in engagement with and interconnecting said fifth and seventh contacts, and said third contact member being in engagement with and interconnecting said fourth and sixth contacts when said movable contact means is in said first position to thereby interconnect said first and second sections in parallel circuit relation with each other and in series circuit relation with said third section between said first and second circuit points to provide a predetermined transformation ratio between said primary and secondary windings; said first contact member being in engagement with and interconnecting said first and third contacts, and said third contact member being in engagement with and interconnecting said fifth and sixth contacts when said movable contact means is in said second position to thereby interconnect said first, second and third sections and said second pair of fuses in series circuit relation with each other between said first and second circuit points to provide a second predetermined transformation ratio between said primary and secondary windings.

6. A transformer comprising a primary winding for connection to a source of supply voltage, a secondary winding for connection to a load, a pair of terminals, one of said windings having a predetermined number of winding turns, first and second protective circuit interrupting means, and means for connecting said one winding selectively in first and second winding arrangements between said terminals to respectively effect first and second transformation ratios between said primary and secondary windings, said one winding when in said first winding arrangement having a preselected number of said winding turns connected in series with each other and said first circuit interrupting means and in series with a winding circuit including a plurality of parallel-connected winding sections each having an equal number of said winding turns, all of said preselected number of winding turns and the winding turns of said winding sections together defining all of the winding turns of said one winding, all of said winding turns of said one winding being connected in series with each other and said second circuit interrupting means when said one winding is in said second winding arrangement.

7. The transformer according to claim **6**, wherein said preselected number of turns is different from the number of turns in each of said winding sections.

8. The transformer according to claim **7**, wherein said first circuit interrupting means is connected between one of said terminals and said one winding to carry the total current of said one winding in both of said first and second winding arrangements.

9. The transformer according to claim **8**, wherein said connecting means includes means for effectively disconnecting said second circuit interrupting means from said one winding when said one winding is in said first winding arrangement.

10. The transformer according to claim **7**, wherein said first and second circuit interrupting means comprise first and second fuses, respectively, and said transformer further includes third and fourth fuses, said first fuse being connected between one of said terminals and one end of said one winding and said third fuse being connected between the other of said terminals and the opposite end of said one winding when said one winding is in said first winding arrangement, said second fuse being connected between said one terminal and said one end of said winding and said fourth fuse being connected between said other terminal and said opposite end of said one winding when said one winding is in said second winding arrangement, said first and third fuses being of a higher current rating than that of said second and fourth fuses and also being connected to carry the total current of said one winding when said one winding is in said second winding arrangement.

11. A transformer comprising primary and secondary windings, a pair of terminals adapted for connection to a source of alternating current, first and second protective circuit interrupting means, and switch means connected with said primary winding and said first and second protective circuit interrupting means and having first and second operating positions for selectively connecting said primary winding respectively in first and second winding arrangement between said terminals, said primary winding when in said first winding arrangement having a first portion thereof connected in series with said first circuit interrupting means and in series with a winding circuit including a plurality of other portions of said primary winding connected in parallel with each other to provide a first predetermined transformation ratio between said primary and secondary windings, said first portion having a different number of primary winding turns than each of said other portions, each of said other portions having an equal number of primary winding turns, all of the winding turns in said other portions and in said first portion together defining all of the winding turns of said primary winding, all of said winding turns of said primary winding being connected in series with each other and said second circuit interrupting means when said primary winding is in said second winding arrangement to provide a second transformation ratio between said primary and secondary windings.

12. The transformer according to claim **11**, wherein said first circuit interrupting means is connected between one of said terminals and said primary winding to carry the total current of said primary winding in both of said first and second winding arrangements.

13. The transformer according to claim **12**, wherein said switch means includes means for effectively disconnecting said second circuit interrupting means from said primary winding when said primary winding is in said first winding arrangement.

14. The transformer according to claim **12**, wherein said first and second circuit interrupting means comprise first and second fuses, respectively, and said first fuse has a higher current rating than said second fuse.

15. The transformer according to claim **14**, including a casing enclosing said primary and secondary windings and said switch means, and at least one primary bushing connected to said casing, said first fuse being connected to said bushing, said one terminal being connected to said bushing and said first fuse.

16. The transformer according to claim **11**, including third and fourth protective circuit interrupting means, said first circuit interrupting means being connected between one of said terminals and one end of said primary winding and said third circuit interrupting means being connected between the other of said terminals and the opposite end of said primary winding when said switch is in said first operating position, said second circuit interrupting means being connected between said one terminal and said one end of said primary winding and said fourth circuit interrupting means being connected between said other terminal and said opposite end of said primary winding when said switch is in said second operating position.

17. The transformer according to claim **16**, wherein said first, second, third and fourth circuit interrupting means are respectively first, second, third and fourth fuses and wherein said first and third fuses have a higher current rating than said second and fourth fuses and wherein all of said fuses are connected in series with said primary winding when said primary winding is in said second winding arrangement.

18. The transformer according to claim **17**, including a casing enclosing said primary and secondary windings and said switch means, a pair of primary bushings connected to said casing, and means connecting said first and third fuses to said terminals respectively through said bushings.

19. The transformer according to claim **17**, wherein said second fuse is effectively disconnected from said primary winding and said fourth fuse is connected in said winding circuit in series with one of said other portions and in parallel with the other of said other portions when said primary winding is in said first winding arrangement.

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