United States Patent [19]

Allen

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[54] **COMBINED ISOLATING AND NEUTRALIZING TRANSFORMER**

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[52] **U.S. Cl.** **336/171**, 336/182, 336/184, 336/188

[51] **Int. Cl.** **H01f 27/28**

[58] **Field of Search** ..... 336/180, 181, 182, 336/184, 214, 215, 155, 170, 171, 188; 307/17, 105, 89; 179/172, 78 R, 80

[56] **References Cited**

UNITED STATES PATENTS

3,418,563	12/1968	Grosu	336/184 X
1,653,107	12/1927	Kochling	336/182

FOREIGN PATENTS OR APPLICATIONS

161,874	8/1933	Switzerland	336/171
3,816,966	9/1963	Japan	336/180

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[57] **ABSTRACT**

A neutralizing transformer in which the communication frequency input cable comprising one or more twisted pairs of wires has each wire of a twisted pair wound on opposite outer legs of the core of the transformer. A similar pair of isolating windings is wound on the same outer legs.

7 Claims, 5 Drawing Figures

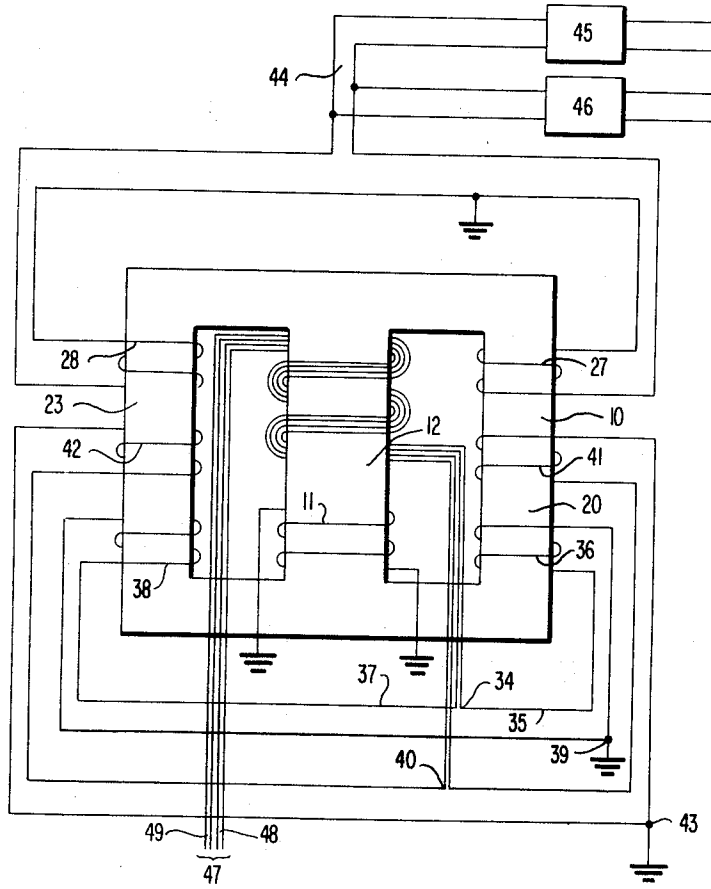


FIG. 3

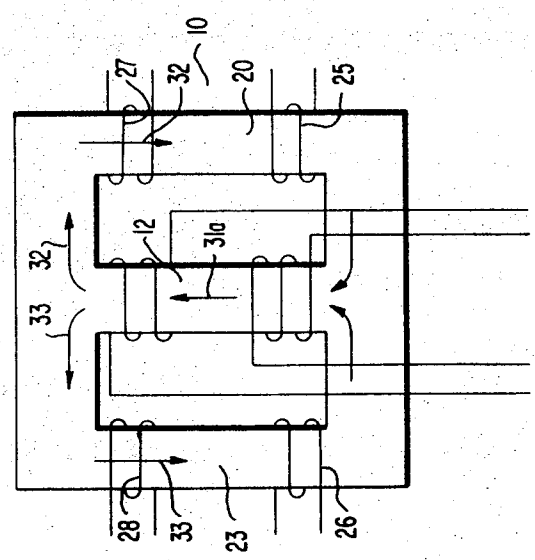


FIG. 2

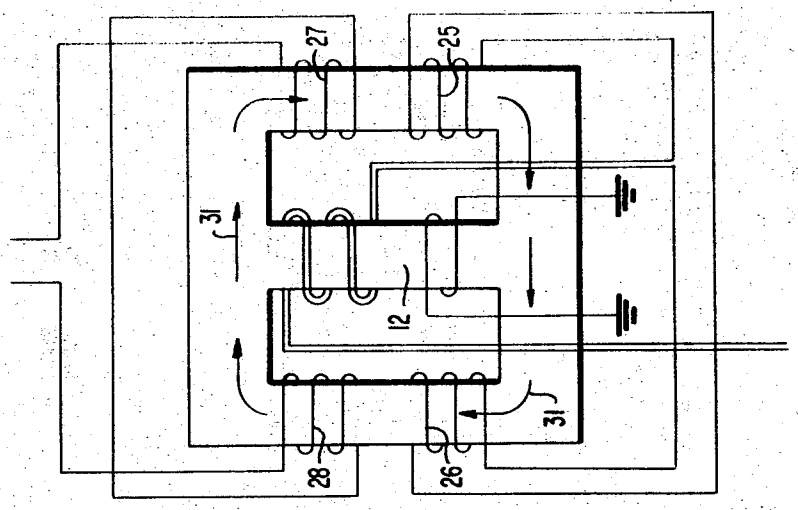
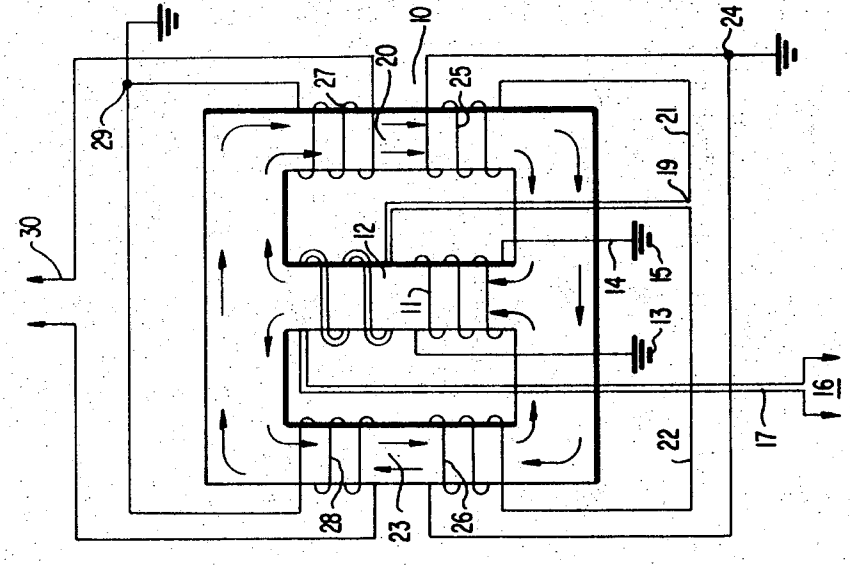


FIG. 1



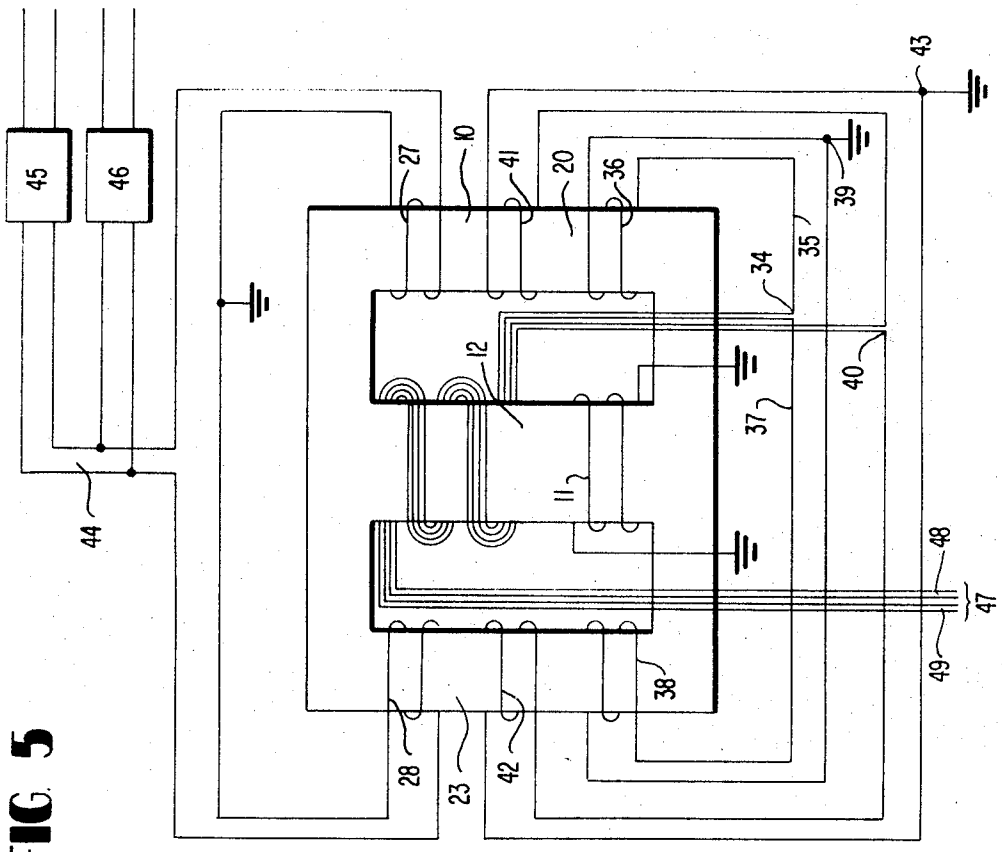

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FIG. 5

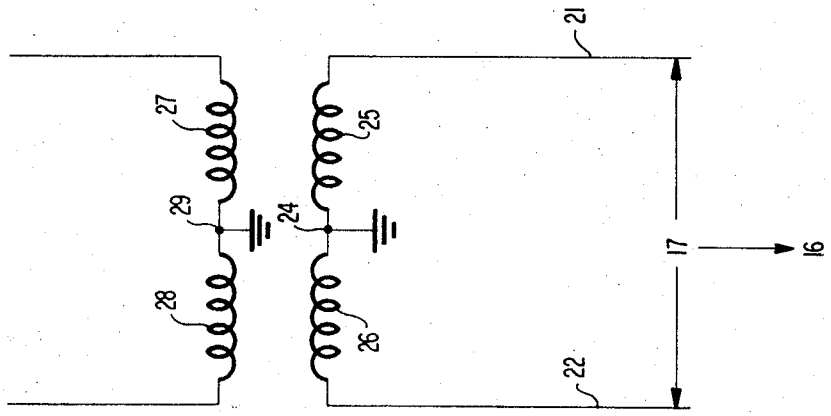
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FIG. 4

COMBINED ISOLATING AND NEUTRALIZING TRANSFORMER

Neutralizing transformers are used to neutralize the effects of ground potential changes and longitudinally induced voltages due to proximity to power lines on communication lines which enter power substations. There are usually further circuits and equipment for drainage of high voltages induced in the communication cable as a result of being struck by lightning and for isolating terminal equipment to prevent such surges and changes in potential due to lightning strikes from damaging the terminal equipment.

This invention relates to a single transformer which can perform the functions of neutralization, isolation and drainage without additional accessory equipment.

Neutralizing transformers are normally built up on a shell-type of transformer core in which the primary winding is wound on the center leg as is the communication cable, representing the secondary, the output of the secondary being the communication frequency input to the terminal equipment. The primary winding is grounded to the substation mat at one end and to a remote ground outside of the influence of the substation ground at the other end, usually taken all the way back to the central telephone office. Thus, when changes in ground potential do arise, the primary winding is excited and bucks out similar changes which have occurred in the audio line. The flux lines circulate through the center leg of the core and then split passing through the outer legs in magnetically opposite directions and joining again as they enter the center leg of the core.

It has been found that because the flux passes through the outer legs of the core in magnetically opposite directions this flux direction provides a way of utilizing the outer legs for additional isolation windings without interference between the neutralizing windings and the isolation windings.

The novelty and uniqueness of this invention are related to the utilization of these formally unused portions of the transformer core and the methods of winding so as to achieve complete electrical and magnetic separation between the neutralizing and isolating functions.

The use of a single core for two separate transformer actions reduces space requirements within the substation and necessary cabling that is associated with using separate units for separate functions.

It is the principal object of this invention to provide a neutralizing transformer which has combined within it a communication line isolation transformer utilizing the same magnetic core.

It is another object of this invention to provide a combined neutralizing transformer and communication line isolation transformer at a reduction in cost over the present equipment.

It is a further object of this invention to provide a combined isolating, drainage and neutralizing transformer wound on a single transformer core.

It is another object of this invention to provide a combined neutralizing and isolating transformer which can be used for selectively neutralizing isolating conductors from multiple conductor communication cable.

Still another object of this invention is to provide a combined neutralizing and isolation transformer which has accurate center taps on the isolation winding for drainage.

These and other objects will become clear upon careful study of the following specification together with the drawings and appended claims.

FIG. 1 shows a schematic view of the transformer showing the neutralization and isolation windings;

FIG. 2 shows a schematic view of the transformer core showing the flux path due to isolation transformer action;

FIG. 3 shows a schematic view of the transformer core indicating the flux path due to the neutralizing transformer action;

FIG. 4 shows a schematic view of the isolation windings in their function as drainage reactors; and

FIG. 5 shows the isolation of a multiple pair input cable.

Referring now to FIG. 1, there is shown transformer shell core **10** having a primary winding **11** wound around the center leg **12.** One end of the primary winding is grounded to a substation grounding mat **13.** The other end of winding **11** is connected by cable **14** to a remote ground mat **15.** The remote ground mat **15** is advantageously located outside of the influence of substation grounding mat **13.** Usually the ground mat **15** is disposed at the central telephone office, while the local ground mat is disposed at the substation at which the transformer is located. Originating from the telephone central office **16** is a balanced twisted pair of communication frequency cables **17.** This cable is wound around the center leg **12** of transformer core **10.**

The construction to this point will be recognized by those skilled in the art as being that of a common neutralizing transformer.

In accordance with the present invention, the individual wires of cable **17** are divided at point **19** which, in normal installations, is connected to the communication output. One wire **21** is wound around outer core leg **20** forming winding **25,** and the other wire **22** is wound around outer core leg **23** forming winding **26.** The remaining free ends of the windings **25** and **26** are connected together at point **24,** thus effectively placing both windings **25** and **26** in series.

Wound on outer core leg **20** is a winding **27,** which is similar to winding **25** below it, as viewed in the drawing. In a similar manner, a winding **28** is wound on outer core leg **23.** Winding **28** is similar to winding **26.** The upper ends of windings **27** and **28,** as viewed in the drawing, are connected together at point **29** effectively putting windings **27** and **28** in series. The other ends of the windings **27** and **28** are brought out to the power station and provide a cable **30** which carries the communication frequency to the power station.

The direction of windings **25** and **26** and windings **27** and **28** is important in that each of the pairs of windings must reinforce rather than buck each other. It will also be observed that the communication frequency intelligence originating at a remote telephone central office **16** will be inductively coupled by windings **25** and **26** to windings **27** and **28** by normal transformer action to output cable **30.** Thus points **16** and **30** are electrically isolated from each other. If windings **25** and **26** are made identical, point **24** represents an accurate center tap position. Similarly, if windings **27** and **28** are made identical, point **29** represents an accurate center tap position.

Referring now to FIG. 2, there are shown flux paths 31 established when communication frequency current is present in windings 25 and 26. It will be noted that the flux is confined to the outer periphery of the core and does not pass through the center core leg 12. It therefore induces a current in windings 28 and 27, but not in the primary or secondary of the neutralizing section of the transformer.

Referring now to FIG. 3, there is shown flux direction 31*a* due to neutralizing transformer action through the center leg 12 of core 10. The flux lines divide into flux path 32 through outer core leg 20, and flux path 33 through outer core leg 23. The flux line through the pair of series connected windings 27 and 28 also cut through windings 25 and 26 and are in opposite directions and therefore cancel each other. Therefore, the sixty cycle current that may be present in the windings on the center core leg 12 will not couple into the windings in the outer legs.

Because of the isolation effect developed by using the core and winding construction described, the disturbing frequencies and/or communication frequencies may be of any value without interference between the neutralizing and isolation sections of the transformer.

The transformer may also be used to provide the action of drainage reactors. Referring to FIG. 4, there is shown a schematic of the series windings 25 and 26 connected across the communication input wires 21 and 22 with the center tap point 24 grounded. One can readily see that if lightning strikes, a shunting effect is provided by the incoming cable 17 which is composed of wires 21 and 22, and which originated at the remote central telephone office 16. Windings 25 and 26 shunt the voltage to ground at the grounded junction point 24. The windings also act as inductors limiting the current to safe levels. Windings 28 and 29 can perform the same function for the output side of the isolating section of the transformer if the center tap 29 is grounded.

The input cable may consist of more than one pair of conductors rather than just one pair, and all pairs or just some, may be isolated by using a separate isolation winding.

To accomplish this requires the use of a carrier or audiotone system in which the intelligence is superimposed on the carrier or otherwise coded to fall within a specific filterable bandwidth.

Referring now to FIG. 5, there is shown transformer core 10 with primary winding 11 wound on center leg 12 as hereinbefore described. Communication frequency input cable 47 consists of two twisted pairs 48 and 49 instead of one as illustrated previously in FIG. 1 and is wound in the same manner on center core leg 12 to provide neutralization. Cable 48 divides at point 34, one wire 35 being wound around core 20, forming winding 36, and the other wire 37 being wound around core leg 23 forming winding 38. The free ends of each winding 36, 38 are connected together at point 39 effectively putting windings 36 and 38 in series. In a like manner, cable 49 is divided at point 40 and wound on outer core legs 20 and 23, forming windings 41 and 42, which are connected in series at point 43.

In a like manner to that in FIG. 1, output windings 27 and 28 are wound around core leg 20 and 23, respectively.

In this arrangement, windings 27 and 28 will have induced in them the combined signals due to windings 36 and 38 and windings 41 and 42, thereby effectively isolating the output 44 from the input cable 31; the signals are intermixed. The output 44 is divided into two parallel paths, one entering filter 45 and the other entering filter 46. Filter 45 is tuned to pass the carrier frequency and intelligence entering the transformer on twisted pair 32, and filter 46 is tuned to pass the carrier frequency and intelligence entering the transformer on twisted pair 33, therefore the intelligence is effectively separated into the two original channels.

One can easily deduce from the above description that any number of incoming pairs may be isolated, limited only by the ability to separate the channels at the output by filtering.

It should also be apparent that modifications may be made in the windings of the isolation portion of the transformer without departing from the novelty and scope of this invention. For example, the windings may be placed on the lower or upper legs following the same principles heretofore described. Further, the core may be constructed with multiple outer legs providing not only additional space for multiple windings, but elimination of the need for filtering between windings on different sets of legs. These and other modifications utilizing the same principles fall within the intended scope of this invention.

That which is claimed is:

1. A combined neutralizing and isolation transformer having its windings wound on a single core, said core comprising a central leg and a pair of outer legs, a first winding wound about said central leg, a second winding wound about said central leg, said second winding comprising a twisted pair of conductors, one of said conductors being wound about one outer leg, the other of said conductors being wound about the other outer leg, the free ends of said conductors being connected together and an isolating winding on each outer core, one of the isolating windings having one of its ends connected to one end of the other of the isolating windings, the other ends of the isolating windings adapted to provide a communication output takeoff.

2. A transformer as set forth in claim 1, wherein the free ends of conductors connected together and the connected ends of the isolating windings include means for providing a common ground connection.

3. A combined neutralizing and isolation transformer having its windings wound on a single core; said core comprising a central leg and a pair of outer legs; said central leg having a plurality of windings thereon forming a neutralizing transformer section and defining with said outer legs two flux paths for flux at power frequencies, this flux being divided into two portions, said portions being directed respectively in the same directional sense through respective ones of said outer legs; each said outer legs having a plurality of windings thereon forming an isolating transformer section, said two outer legs defining with other portions of said single core a closed flux path for flux at signal frequencies above the power frequencies, said central leg being substantially free of flux at frequencies above the power frequences; wherein said plurality of windings on said outer legs include a first pair of windings serially connected, each disposed on separate ones of said outer legs and connected to one of said windings on said central leg, and a second pair of windings one end of which is serially connected to one another and the other end providing a pair of output points; and wherein said plurality of windings on said central leg

includes a primary winding and a plurality of input windings, each said input winding comprising a cable having a twisted pair of conductors, each conductor of a pair being wound about one of said outer legs to provide corresponding pairs of windings for each input winding.

4. A transformer as set forth in claim **3**, wherein each said corresponding pair of windings includes means for providing a common ground connection.

5. A combined neutralizing and isolation transformer comprising a single core having a central leg and at least two other legs, a first winding wound about said central leg, a plurality of input windings wound about said central leg, each said input windings comprising turns of a twisted pair of wires, one wire of each twisted pair being wound about one of the other legs, the other wire of each twisted pair being wound about the other of the legs and means for joining each winding formed by the wires to provide series connected windings and an isolating winding on each outer core, said isolating windings having one of their ends joined together effectively placing the windings in series and the other of their ends providing an output connection.

6. A transformer as set forth in claim **5**, including at least a pair of output channels, means for connecting the output channels to the output connection including separate filter means for passing the carrier frequency and intelligence adapted to be applied to the input windings.

7. A transformer as set forth in claim **6**, including means for connecting joined ends of the windings to ground.

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