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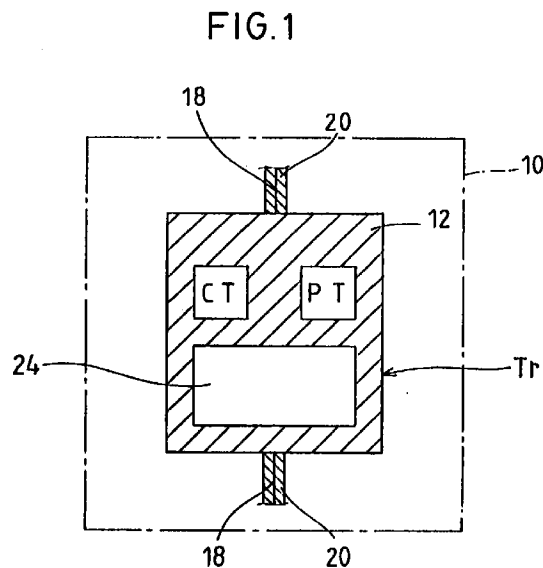
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(54) **Integrated transformer having functions of receiving and transforming equipment**

(57) The aim is to prevent electric shock accidents, and to reduce the size of the equipment. The coils of a current transformer CT and an instrument transformer PT are disposed in close proximity to the coil 24 of a power distribution transformer Tr, so that these coils are electrically connected by electromagnetic induction. The areas surrounding the coil 24 of the power distribution transformer Tr and the coils of the current transformer Tr and instrument transformer PT are filled with an insulating molding material 12, so that an integral block is formed, thus constructing a transformer Tr which has the function of a receiving and transforming equipment with an integral current transformer CT and instrument transformer PT. More specifically, the coil 24 of the power distribution transformer Tr and the coils of the current transformer CT and instrument transformer PT are molded into integral unit by means of an insulating molding material 12, so that no high-voltage parts of such coils are exposed to the outside.



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**Description****BACKGROUND OF THE INVENTION****Field of the Invention**

The present invention relates to an integrated transformer having functions of receiving and transforming equipment and more particularly to an integrated transformer having functions of receiving and transforming equipment in which the coil of a power distribution transformer and the coils of a current transformer (CT) and an instrument transformer (PT) are electrically connected by electromagnetic induction, so that such coils are formed into an integral block by an insulating molding material and so that the transformer has the function of a receiving and transforming equipment.

**Description of the Related Art**

Inside cubicles installed at substations, etc., current transformers used for current measurement, instrument transformers used for voltage measurement, and relays, etc. are installed in a prescribed layout around power distribution transformers, and these respective devices are connected by cables. Furthermore, dry molded transformers, which are molded by means of a synthetic resin, etc. in order to prevent deterioration and insure insulation, are known as the power distribution transformers.

In transforming equipment that includes power distribution transformers, current transformers and instrument transformers, etc., the respective devices are constructed as separate units and installed inside the cubicles; accordingly, the connecting parts of such devices and the cables themselves are exposed inside each cubicle. Thus, when workers enter the cubicle so as to perform cleaning, maintenance or inspection work on the respective devices making up the transforming equipment, there is a danger that the workers may suffer an electric shock as a result of inadvertently touching the exposed high-voltage parts. As a result, such work is extremely dangerous. Furthermore, since the respective devices are separately installed, work inside the cubicle is difficult, the interior space is not effectively utilized, the size of the equipment tends to be large, and the manufacturing costs are high. In addition, the ammeters connected to the conventional current transformers are of a movable coil type in which a large current flows when the indicator needles of such ammeter are operated, thus causing electric shock accidents. Furthermore, since the voltmeters connected to the instrument transformers are of a contact type, such voltmeters have likewise been a cause of electric shock accidents.

In addition, insects, rats, etc. often penetrate into the interiors of the cubicles; in such cases, these insects, rats, etc. may contact exposed high-voltage parts, thus suffering an electric shock and causing dete-

rioration of or damage to current transformers and instrument transformers. In other words, inside conventional cubicles, countermeasures against electric shock accidents suffered by workers and electric shock accidents caused by rats, etc. are insufficient. For example, several hundred electric shock accidents involving workers occur each year, and proposals for solving this problem have been awaited.

**SUMMARY OF THE INVENTION**

The present invention was devised in light of the drawbacks inherent in the prior art described above and so as to eliminate these drawbacks in an appropriate manner. The object of the present invention is to provide an integrated transformer having functions of receiving and transforming equipment, which prevents the occurrence of electric shock accidents and which makes it possible to reduce the size of the equipment.

In order to accomplish the object, the integrated transformer having functions of receiving and transforming equipment of the present invention is characterized in that the coils of a current transformer and an instrument transformer are installed in close proximity to the coil of a power distribution transformer so that these coils are electrically connected by electromagnetic induction, and the areas surrounding the coil of the power distribution transformer and the coils of the current transformer and instrument transformer are filled with an insulating molding material consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that an integral block is formed.

Furthermore, in order to accomplish the object, the integrated transformer having functions of receiving and transforming equipment which is provided by another invention of the present application is characterized in that:

the outer surface of the coil of a power distribution transformer is covered to a prescribed thickness with an insulating molding material consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a block is formed;

the areas surrounding this molded transformer coil block and the coils of a current transformer and instrument transformer that are to be connected to the transformer coil are filled with an insulating molding material consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a further integral block is formed; and

the respective coils of the current transformer and instrument transformer and the coil of the power distribution transformer are electrically connected by electromagnetic induction inside the insulating molding material.

Furthermore, in order to accomplish the object, the integrated transformer having functions of receiving and transforming equipment which is provided by another invention of the present application is characterized in that:

the outer surface of the coil of a power distribution transformer is covered to a prescribed thickness with an insulating molding material consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc. so that a block is formed;

the areas surrounding this molded transformer coil block, the coils of a current transformer and instrument transformer that are to be connected to the transformer coil, and a relay that is to be connected to the transformer coil, are filled with an insulating molding material consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc. so that a further integral block is formed; and

the respective coils of the current transformer and instrument transformer are electrically connected to the coil of the power distribution transformer by electromagnetic induction, while the relay is electrically connected to the coil of the power distribution transformer by wiring.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an explanatory diagram which illustrates an integrated transformer having functions of receiving and transforming equipment, constituting a first embodiment of the present invention.

Figure 2 is an explanatory diagram which illustrates the positional relationship between the current transformer and instrument transformer and the windings.

Figure 3 is a circuit diagram, shown as one example, of the integrated transformer having functions of receiving and transforming equipment which constitutes the first embodiment.

Figure 4 is an outside front view of an integrated transformer having functions of receiving and transforming equipment.

Figure 5 is an explanatory diagram which illustrates an integrated transformer having functions of receiving and transforming equipment, constituting a second embodiment of the present invention.

Figure 6 is an explanatory diagram which illustrates an integrated transformer having functions of receiving and transforming equipment, constituting a third embodiment of the present invention.

Figure 7 is an explanatory diagram which illustrates an integrated transformer having functions of receiving and transforming equipment, constituting a fourth embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Next, preferred embodiments of the integrated transformer having functions of receiving and transforming equipment which is provided by the present invention will be described with reference to the attached figures.

##### (First Embodiment)

Figure 1 is a schematic structural diagram of an integrated transformer having functions of receiving and transforming equipment, which constitutes a first embodiment of the present invention. The coil of a current transformer CT and the coil of an instrument transformer PT are installed, in a non-contact state, in close proximity to a coil 24 of a power distribution transformer Tr (single-phase or three-phase combination, etc.), so that these coils are electrically connected by electromagnetic induction. Furthermore, the areas surrounding the coil of the transformer Tr and the coils of the current transformer CT and instrument transformer PT are filled with an insulating molding material 12 so that an integral block is formed. In this way, a transformer Tr which has the function of receiving and transforming equipment with an integrated current transformer CT and instrument transformer PT is constructed. More specifically, the coil 24 of the transformer Tr and the coils of the current transformer CT and instrument transformer PT are molded into an integral unit by means of the insulating molding material 12 so that the high-voltage portions of such coils are not exposed to the outside. Furthermore, this transformer Tr which functions as an integrated type receiving and transforming equipment is installed inside a cubicle 10 which is used as an outer covering. A synthetic resin such as an epoxy resin or polyester resin, etc., or a synthetic rubber such as a butyl or ethylene-propylene rubber, etc., may be appropriately used as the insulating molding material 12. Furthermore, when the coil 24 of the transformer Tr and the coils of the current transformer CT and instrument transformer PT are molded into an integral unit, such a molding may be performed so that the magnetic fields of the coils do not extend to the outside of the molding or so that the magnetic fields can extend to the outside of the molding.

Figure 2 shows the relationship between the coil 24 of the transformer Tr and the coils of the digital type current transformer CT and instrument transformer PT in schematic form; and it is designed so that the current is measured by an ammeter A, with the coil of the current transformer CT being caused to face one winding 19 of the coil 24 of the transformer Tr in a non-contact state (see Figure 2(a)) and so that, as shown in Figure 2(b), the voltage is measured by a voltmeter V, with the coil of the instrument transformer PT being caused to face one winding 19 of the coil 24 of the transformer Tr in a non-contact state. In other words, since the voltage applied

to one winding 19 of the coil 24 is extremely small, by installing the coils of the current transformer CT and instrument transformer PT in a non-contact state at an extremely small distance from the winding 19, the current flowing through the current transformer CT and instrument transformer PT can be reduced to an extremely small value (e. g., 0.1 mA to 0.01 mA). As a result, the generation of heat can be minimized, and safety can be improved. A reduction in cost can also be achieved. Meanwhile, the ammeter A and voltmeter V are integrally incorporated into the interior portion of the insulating molding material 12.

Furthermore, in the manufacturing process of the transformer Tr, the current transformer CT and instrument transformer PT are manufactured as an integral unit with the transformer Tr, so that no electric-charged parts are exposed to the outside of the transformer unit. Moreover, it is possible to install the ammeter A connected to the current transformer CT and the voltmeter V connected to the instrument transformer PT on the outside of the insulating molding material 12.

Figure 3 shows one example of a circuit diagram of the transformer Tr. Here, measurement in the instrument transformer PT is accomplished by electromagnetic induction between the coil 24 (secondary winding) of the transformer Tr and the coil (tertiary winding) of the instrument transformer PT. Furthermore, measurement in the current transformer CT is accomplished by electromagnetic induction between the coil 24 (secondary winding) of the transformer Tr and the coil of the current transformer CT. Thus, the coil 24 of the transformer Tr and the coils of the current transformer CT and instrument transformer PT are electrically connected in a non-contact state by electromagnetic induction; accordingly, the currents flowing through these electrical measuring instruments can be extremely small, and a conspicuous reduction in the size of the transformer can be achieved. Furthermore, in the circuit shown in Figure 3, the current transformer CT and instrument transformer PT are connected to a measurement/display/data output/printer print out section 26 which is provided inside the coil. In this output section 26, voltage, current, electric power, phase, open phase and high frequency values are digitally displayed, and if necessary, these values can be printed out. Incidentally, the output section 26 is equipped with, for instance, a liquid crystal panel 28 which is installed in a prescribed position on the outside surface of the transformer Tr shown in Figure 4, so that the display of various measured values or data can be switched by means of a switching button 30 provided in the output section 26. Furthermore, it is also possible that the coil of the current transformer CT is electrically connected to the coil 24 (primary winding) of the transformer Tr or the coil (tertiary winding) of the instrument transformer PT by electromagnetic induction.

The cables 18 which are led into the interior of the cubicle 10 and connected to the transformer Tr are also molded by an insulating molding material 20. Accord-

ingly, since no high-voltage parts are exposed inside the cubicle 10, there is no danger that workers will be exposed to an electric shock when they enter the cubicle 10 to perform cleaning, maintenance or inspection work on the respective devices. Furthermore, since the current transformer CT and instrument transformer CT and instrument transformer PT are molded, the durability and useful life of such devices are improved, and deterioration or damage that might be caused by insects, rats, etc., coming into contact with a high voltage is prevented before the fact. Furthermore, a transparent, flexible molding material which allows viewing of the interior (cable) for purposes of inspection, etc. is appropriate for use as the insulating molding material 20 of the cables 18.

Furthermore, in regard to the coil 24 of the transformer Tr itself, since a block is formed by filling the area surrounding the coil 24 with an insulating molding material 12, there is almost no danger of fire or some other type of accident being caused by heat generated by the coil 24, etc. Moreover, in regard to the current transformer CT and instrument transformer PT, an extremely weak current flows through such devices as described above; accordingly, there is very little likelihood of an accident occurring, and such devices will function accurately throughout their useful lives. Incidentally, the capacity of the transformer Tr may be any desired capacity, ranging from a small capacity to a large capacity; to give actual examples, transformers with capacities ranging from, for example, 2,000 KVA to 20,000 KVA may be used. Furthermore, even in the case of a large-capacity transformer, there is very little likelihood of fire or other accidents.

It is recommended that through-holes (not shown in the figures) which communicate with the outside be formed in the insulating molding material 12 in positions corresponding to the positions of the current transformer CT and instrument transformer PT, so that heat dissipation can be accomplished. Furthermore, it is also possible to make the connections between the transformer Tr and the cables 18, which are installed inside the cubicle 10, at locations (e. g., in the ground) where there is no danger that workers will come into contact with such connections, rather than making such connections inside the cubicle 10, so that the exposure of high-voltage parts inside the cubicle 10 is completely eliminated.

#### (Second Embodiment)

Figure 5 is a schematic structural diagram of an integrated transformer having functions of receiving and transforming equipment, which constitutes a second embodiment of the present invention. Here, the outer surface of the coil 24 of a power distribution transformer Tr is covered to a prescribed thickness with an insulating molding material 22 so that a block is formed. The areas surrounding the block of the coil 24 of this molded transformer Tr and the coils of a current transformer CT and

instrument transformer PT that are connected to the coil 24 of the transformer Tr are filled with an insulating molding material 12 so that an integral block is formed. Furthermore, the coils of the current transformer CT and instrument transformer PT, and the coil 24 of the transformer Tr, are electrically connected by electro-

5 magnetic inductance in the same manner as in the embodiment described previously inside the insulating molding materials 22 and 12. In other others, in the transformer Tr which functions as an integrated trans-

10 former having functions of receiving and transforming equipment constructed according to the second embodiment as well, there is no exposure of high-voltage parts; accordingly, the occurrence of fires and electric shock accidents involving workers can be prevented.

15 Furthermore, through-holes 12a and 12a which communicate with the outside are formed in the insulating molding material 12 in positions corresponding to the positions of the current transformers CT and instrument transformer PT, so that the dissipation of heat can be promoted.

### (Third Embodiment)

Figure 6 is a schematic structural diagram of an integrated transformer having functions of receiving and transforming equipment, which constitutes a third embodiment of the present invention. Here, the areas surrounding the block of a coil 24 of the transformer Tr molded by means of an insulating molding material 22, the coils of a current transformer CT and an instrument transformer PT that are connected to the coil 24 of the transformer Tr, and a relay VCB that is connected to the transformer Tr, are filled with an insulating molding material 12 so that an integral block is formed. Further-

25 more, the coils of the current transformer CT and instrument transformer PT are electrically connected to the coil 24 of the transformer Tr by electromagnetic induction, and the relay VCB is electrically connected to the coil 24 of the transformer Tr by wiring. As a result of the areas surrounding the coil 24 of the transformer Tr, the relay VCB and the coils of the current transformer CT and the instrument transformer PT being filled with the insulating molding material 12 so as to form the integral block, an integrated transformer Tr having functions of receiving and transforming equipment with an inte-

30 grated current transformer CT, instrument transformer PT and relay VCB is constructed.

Furthermore, in this third embodiment, the coil of another current transformer CT is electrically connected to the secondary side of the coil 24 of the transformer Tr by electromagnetic induction, and the coil of this current transformer CT is also molded by means of the insulating molding material 12 so that an integral block is formed. As a result, no high-voltage parts are exposed. Furthermore, the cables 18 installed inside the cubicle 10 are also covered with a molding material 20 such as a transparent, flexible insulating material, etc.

An overcurrent detection circuit (or demand meter)

14 which is installed on the outside of the insulating molding material 12 is connected to the current transformer CT which is connected to the secondary side of the coil 24 of the transformer Tr; furthermore, this over-

5 current detection circuit 14 is connected to the relay VCB. In cases where a current exceeding a prescribed value flows through the transformer Tr, this current is detected by the current transformer CT, and the relay VCB is actuated by the overcurrent detection circuit 14 so that the circuit is instantaneously broken, thus protecting the transformer Tr. Furthermore, a through-hole 12c is formed in the insulating molding material 12 in a position corresponding to the position of the relay VCB, so that the dissipation of heat and the movement of movable parts can be smoothly accomplished.

Instead of actuating the relay VCB by means of the overcurrent detection circuit 14, it is possible to cause an appropriate warning lamp to light up, or to produce a warning sound by means of a buzzer, etc. Moreover, the overcurrent detection circuit 14 and current transformer CT used for transformer protection can be installed on the primary side of the transformer Tr. The use of an overcurrent detection circuit 14 in this way offers such an advantage that the transformer Tr can be supplied to the user in terms of units of actual use kW (= kVA x power factor) rather than in terms of units of maximum power used kVA.

Furthermore, in this third embodiment, the relay VCB and the coil 24 of the transformer Tr are molded into an integral unit. As a result, no portion of the system in the area extending from the relay VCB to the coil 24 of the transformer Tr is exposed; accordingly, electric shock accidents in this area can be prevented. Moreover, since there is no need for cables, etc., to be connected to the respective devices, costs can be reduced, and the size of the equipment as a whole can be further reduced. In addition, it is possible to install a separately molded freely detachable relay VCB in a transformer Tr with integrally molded current transformers CT and instrument transformer PT. Furthermore, it is also possible to mold the coil 24 of the transformer Tr, the coils of the current transformers CT and instrument transformer PT and the relay device VCB into an integral unit using only the insulating molding material 12.

In cases where the relay VCB and the coil 24 of the transformer Tr are molded into an integral unit as in this third embodiment, there is very little chance that there will be any trouble with the relay VCB during the useful life of the coil 24 of the transformer Tr, since the number of times that the relay VCB is actually operated is only a few times a year of in some cases not even once a year, while the useful life of the relay VCB corresponds to operation several tens of thousands of times. In other words, there is hardly ever a need for replacement prior to the expiration of the useful life of the system, so that running costs can be reduced.

Furthermore, by means of combined wiring (V-V wiring) of single-phase transformers, it is possible to use only a single secondary-side low-voltage cable.

Accordingly, by connecting an internally mounted current transformer CT to this, it is possible to omit the main breaker, so that the number of parts can be reduced, thus allowing a reduction in cost.

#### (Fourth Embodiment)

Figure 7 is a schematic structural diagram of an integrated transformer having functions of receiving and transforming equipment, which constitutes a fourth embodiment of the present invention. Here, the outer surface of the coil 24 of a power distribution transformer Tr is covered to a prescribed thickness with an insulating molding material 12 so that a block is formed. Furthermore, the outer surfaces of current transformers CT or instrument transformers PT that are to be electrically connected with the coil 24 of the transformer Tr are also covered to a prescribed thickness with an insulating molding material 16 so that respective blocks are formed. Moreover, a prescribed number of recesses 12b are formed in the surface of the molded block containing the coil 24 of the transformer Tr, and the respective molded blocks containing the coils of the current transformers CT or instrument transformers PT are inserted and fastened, in a freely detachable manner, inside the recesses 12b. These blocks containing current transformers CT or instrument transformers PT are fastened to the insulating molding material 12 via appropriate fastening fittings (not shown in the figure). Furthermore, the coils of the current transformers CT or instrument transformers PT and the coil 24 of the transformer Tr are electrically connected by electromagnetic induction inside the insulating molding materials 12 and 16. Moreover, through-holes 12a which communicate with the outside are formed in each of the recesses 12b of the insulating molding material 12, so that heat dissipation can be promoted.

In the configuration in which blocks containing the coils of current transformers CT or instrument transformers PT are integrated in a separable manner with the block containing the coil 24 of the transformer Tr as in this fourth embodiment, it is possible to replace only the blocks containing the current transformers CT or instrument transformers PT. Furthermore, in the construction of this fourth embodiment, it is possible to install a separately molded relay VCB in a freely detachable manner.

#### Claims

1. An integrated transformer having functions of receiving and transforming equipment characterized in that:

coils of a current transformer (CT) and of an instrument transformer (PT) are installed in close proximity to a coil (24) of a power distribution transformer (Tr), so that said coils are electrically connected by electromagnetic

induction, and

areas surrounding said coil (24) of said power distribution transformer (Tr) and said coils of said current transformer (CT) and instrument transformer (PT) are filled with an insulating molding material (12) consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that an integral block is formed.

2. An integrated transformer having functions of receiving and transforming equipment characterized in that:

an outer surface of a coil (24) of a power distribution transformer (Tr) is covered to a prescribed thickness with an insulating molding material (22) consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a block is formed,

areas surrounding thus molded transformer (Tr) coil (24) block and coils of a current transformer (CT) and instrument transformer (PT) that are to be connected to said transformer coil are filled with an insulating molding material (12) consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a further integral block is formed, and

respective coils of said current transformer (CT) and instrument transformer (PT) and said coil (24) of said power distribution transformer (Tr) are electrically connected by electromagnetic induction inside said insulating molding material (22,12).

3. An integrated transformer having functions of receiving and transforming equipment characterized in that:

an outer surface of a coil (24) of a power distribution transformer (Tr) is covered to a prescribed thickness with an insulating molding material (22) consisting of a synthetic resin such as an epoxy resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a block is formed,

areas surrounding thus molded transformer (Tr) coil (24) block, coils of a current transformer (CT) and instrument transformer (PT) that are to be connected to said transformer (Tr) coil (24), and a relay (VCB) which is to be connected to said transformer (Tr) coil (24), are filled with an insulating molding material (12) consisting of a synthetic resin such as an epoxy

resin, etc., or a synthetic rubber such as a butyl rubber, etc., so that a further integral block is formed, and

respective coils of said current transformer (CT) and instrument transformer (PT) are electrically connected by electromagnetic induction, while said relay (VCB) is electrically connected to said coil (24) of said power distribution transformer (Tr) by wiring.

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FIG. 1

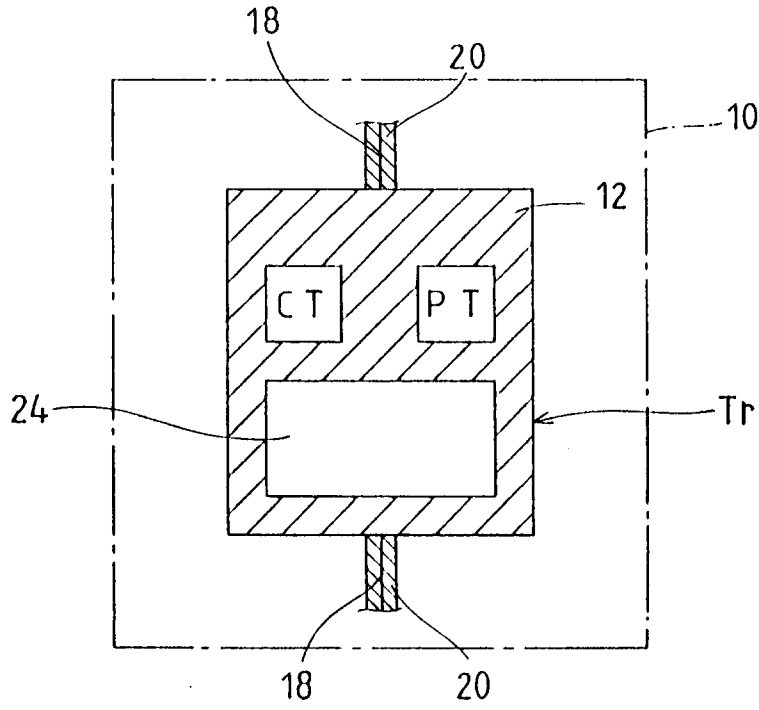


FIG. 4

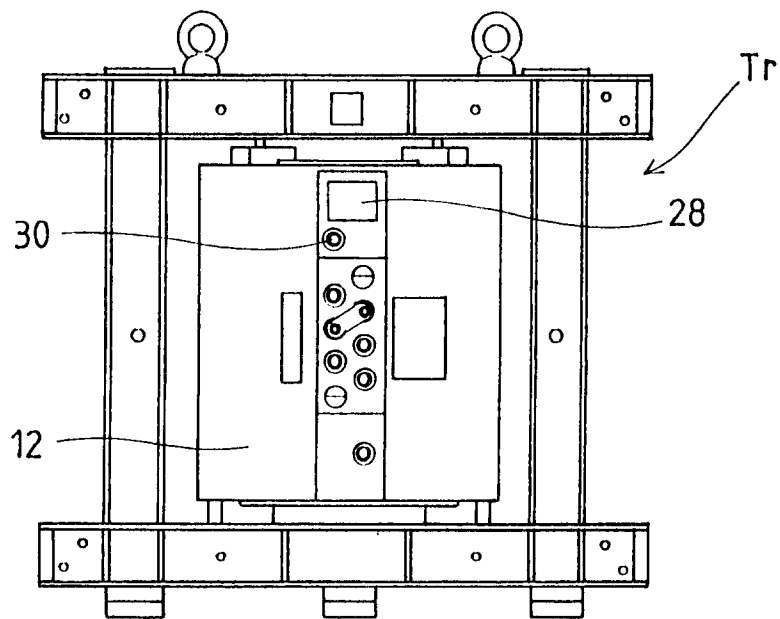


FIG. 5

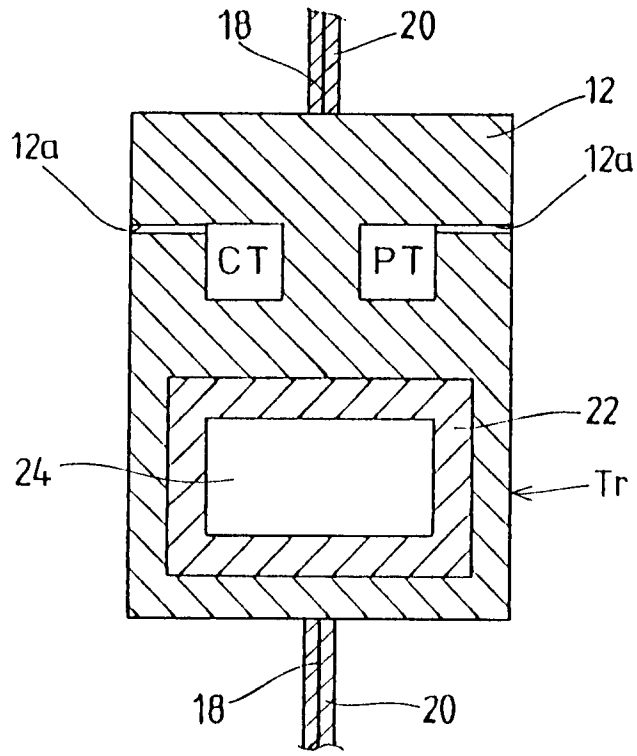


FIG. 2

(a)

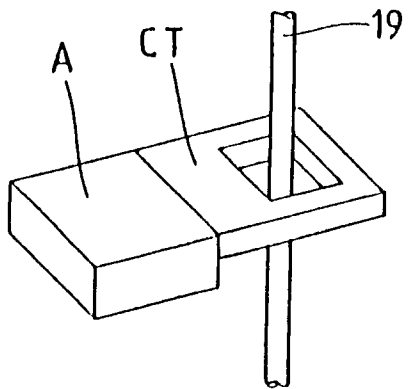


FIG. 2

(b)

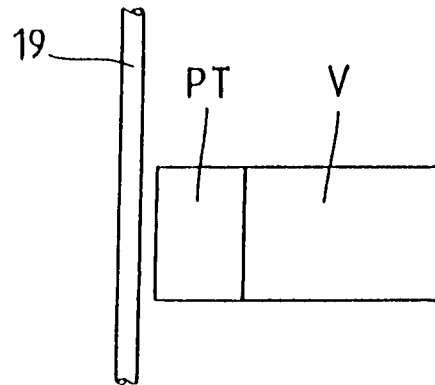


FIG. 3

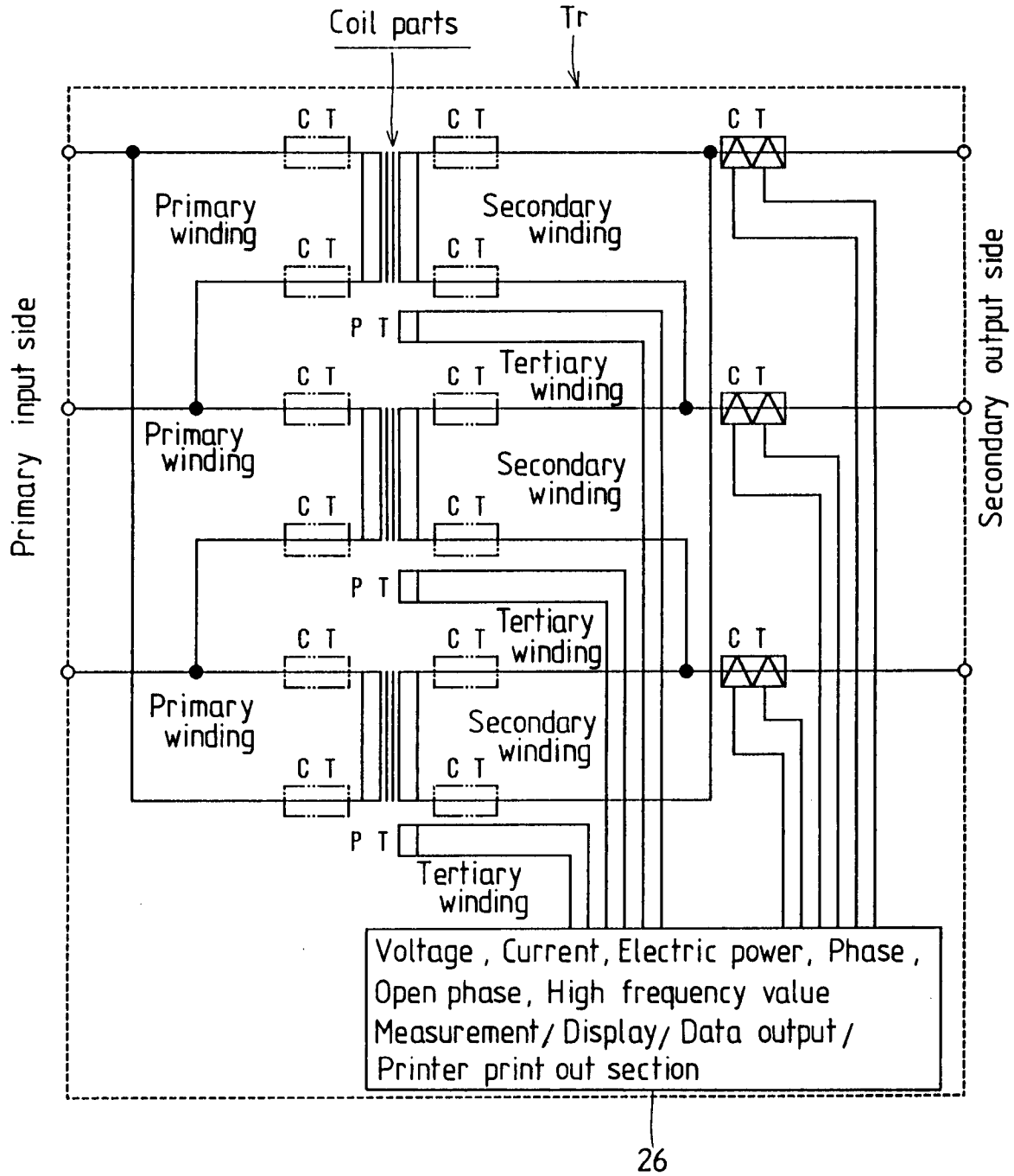


FIG. 6

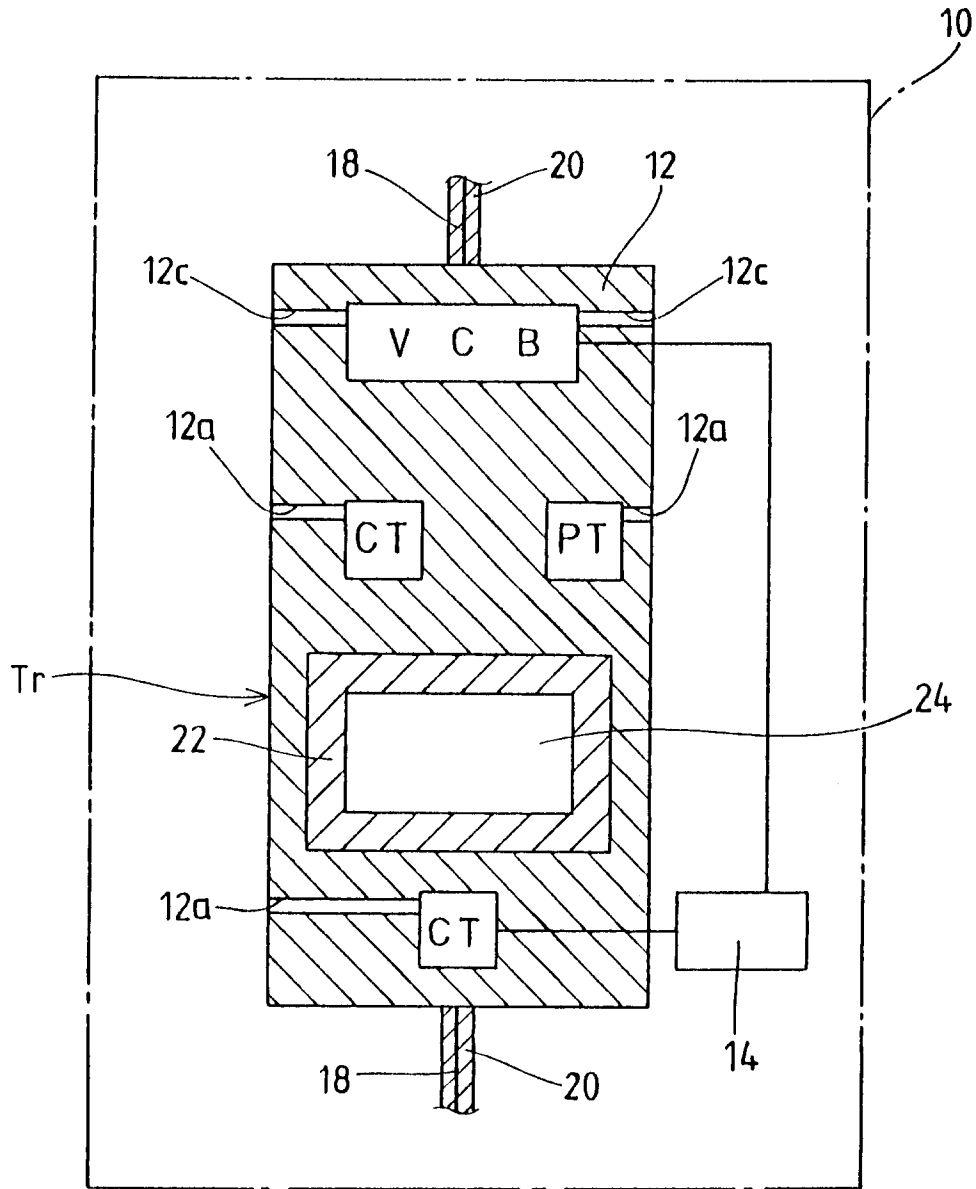


FIG. 7

