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MOLDED CAPACITOR

The present invention relates to a molded capacitor.

A molded capacitor is made by connecting a plurality of capacitor elements electrically and molding the assembly with synthetic resin. With this type of capacitor in which the capacitor elements are covered by resin, impregnation of resin at the ends of the capacitor elements has to be sufficient. Otherwise, partial discharge will tend to occur, thus causing breakdown of the capacitor. But, it is very difficult or almost impossible to completely impregnate the capacitor elements with synthetic resin at their recessed end portions. Thus, the capacitor elements tend to suffer from corona discharge at their end portions.

With the prior art molded capacitors, this problem is tackled by reducing the voltage assigned to each capacitor element. This increases the number of capacitor elements and makes the capacitor bulky and expensive.

In the light of these drawbacks with the prior art molded capacitors, the present inventors have conceived the idea of encasing each capacitor element in a stiff container, filling an insulating gas therein, and molding the containers with synthetic resin.

With a prior art molded capacitor, each capacitor element is vacuum-packed in a flexible synthetic resin film

pack and an insulating gas is filled in the film pack. With this type of capacitor, it is relatively easy to vacuum-pack the capacitor elements and then fill the film packs with an insulating gas. But, the insulating gas in the film packs expands or contracts in molding the vacuum-packed capacitor elements with synthetic resin, so that air gaps are liable to develop between the film packs and the molding resin.

The air gaps may induce corona discharge. If the film packs are in tight contact with the molding resin and no air gaps develop therebetween, the film packs cannot contract after it has expanded by the temperature rise during molding. This will cause the pressure of the insulating gas in the film packs to drop, thus lowering the corona discharge starting voltage.

An object of the present invention is to provide a molded capacitor which obviates the abovesaid shortcomings.

The inventors reached a concept of encasing the capacitor elements in a stiff casing having a shape-retaining property, filling an insulating gas in the casing, electrically connecting a plurality of the encased capacitor elements together, and molding the assembly with synthetic resin.

The inventors also noticed the necessity that the casing should have a good adhesion with the molded resin at its outer periphery, and have completed the present

invention.

SUMMARY OF THE INVENTION

5 According to the present invention, a capacitor comprises:

 a plurality of inner casings having a shape retaining property; capacitor elements mounted in said respective inner casings; said inner casings
10 being filled with an insulating fluid; said capacitor elements being connected electrically with one another to form an assembly; and an outer housing formed by encapsulating said inner casings with synthetic resin.

15 According to the present invention, a capacitor comprises:

 a plurality of inner casings having a shape retaining property; capacitor elements mounted in said respective inner casings; said inner casings
20 being each filled with an insulating fluid and individually encapsulated with synthetic resin to seal said insulating fluid therein; said capacitor elements being connected electrically with one another to form an assembly; and an outer housing
25 formed by encapsulating said inner casings with

synthetic resin.

The container for the capacitor element is less subject to deformation even if the insulating gas or oil in the container expands and contracts, because not only is it made of a material having a shape retention or stiffness but also it is reinforced with the molding resin. The molding resin impregnates the glass fiber material wound around each container so as to improve the bonding strength between the container and the resin molding.

With the present invention, air gaps hardly develop between the resin molding and the containers. This reduces the possibility of causing corona discharge and makes it possible to increase the voltage assigned to each capacitor element and reduce the number of capacitor elements in one capacitor. This makes the capacitor more compact.

Since each of the molded capacitor elements can be tested individually for performance before being connected together, defective elements can be easily picked out before assembly. This will lead to a reduction in the number of defective capacitors.

Further, since each capacitor element is encased in a

stiff container having a shape retaining property, the molding resin is kept out of direct contact with metal-sprayed electrical connecting points of the capacitor elements. Thus, the connecting points are less susceptible to the stress produced when the resin molding contracts during hardening.

Other features and objects of the present invention will become apparent from the following description taken with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view of the first embodiment of the capacitor according to the present invention:

Fig. 2 is an enlarged sectional view of a portion of the same; and

Fig. 3 is a sectional view of a second embodiment.

As shown in Fig. 1, the capacitor 1 in the first embodiment of the present invention comprises a plurality of encased and molded capacitor elements 11 connected together electrically with one another, and an outer housing 2 for the capacitor elements formed by molding a synthetic resin. The outer housing 2 is integrally formed with bushings 3.

As shown in Fig. 2, each encased and molded capacitor element 11 comprises a container or casing 4 and a capacitor element 5 housed therein. The casing 4 is filled with an

insulating gas such as SF₆ gas or nitrogen gas and has a glass fiber material 12 wound around its outer periphery. This casing is encapsulated in a molding of a synthetic resin so as to hermetically seal the insulating gas. The capacitor element 11 is manufactured in the following manner.

Firstly a casing 4 is prepared. The casing 4 comprises a body 4a having an open top and a lid 4b closing a top opening of the body 4a. The body 4a and the lid 4b are both made of synthetic resin and formed with holes 7 and 7' for lead wires 6 of the capacitor element 5, respectively. The casing 4 has inner dimensions slightly larger than the outer dimensions of the capacitor element 5 which comprises dielectric layers and electrode layers alternately wound in a spiral-shape. The lid 4b is put on the body 4a so that a gap 8 will be formed therebetween. The gap 8 and gaps 9 formed between the lead wires 6 and the holes 7 and 7' should be large enough to allow the insulating gas to pass into the casing 4 but not so large as to permit the invasion of a highly viscous synthetic resin into the container when the container is molded.

The inner casing 4 should be made of a stiff or rigid material having high heat resistance and insulating and shape-retaining properties, such as polyester resin, polystyrene resin and polycarbonate resin.

After encasing the capacitor element 5 in the body 4a, the lid 4b is put on the body with the lead wires 6 having their ends drawn out of the casing 4 through the holes 7 and 7'.

After the outer surface of the casing 4 has been roughened in the manner which will be described below, the glass fiber material 12 is wound around the outer periphery of the casing 4. The casing is then put in a metal mold and the mold is evacuated. An insulating gas such as SF₆ gas or nitrogen gas is admitted into the mold. Then, a highly viscous synthetic resin such as epoxy or urethane resin is poured into between the mold and the casing 4. After the resin has hardened, it is released from the mold.

The casing 4 is thus encapsulated or molded (first molding) in the molding 10 of synthetic resin which serves to fill up the gap 8 between the casing body 4a and the lid 4b and the gaps 9 between the lead wires 6 and the holes 7 and 7' so as to hermetically seal the insulating gas in the casing 4. A numeral 10 indicates a molded layer.

A plurality of molded capacitor elements 11 thus produced are connected in parallel and series with one another and put in a metal mold. A synthetic resin (preferably epoxy resin) is poured into the mold (the second molding), hardened and then released from the mold. The molding by the second molding forms an outer housing. The

molded capacitor according to the first embodiment is thus made. An insulating oil may be used instead of an insulating gas.

In the second embodiment shown in Fig. 3, a plurality of capacitor elements 5 are encased in the respective casings 4 and are encapsulated in an outer housing 2 formed by molding a synthetic resin such as epoxy resin. This embodiment is different from the first embodiment in that the molding is carried out only once, not twice as in the first embodiment, to hermetically seal the insulating gas. In this embodiment, too, an insulating oil may be used instead of an insulating gas.

In any of the embodiments, the casing 4 comprises the body 4a and the lid 4b and is made of polyester, polystyrene or polycarbonate resin. It has such a thickness as not to be deformed by the expansion and contraction during molding.

In any of the embodiments, the casing 4 should preferably have its outer periphery roughened. The roughened surface may be formed by etching or sandblasting or by electrostatically flocking the outer periphery with short fibers of synthetic resin. Its roughness should be set at about 10-100 microns in terms of the difference of

height of high portions or the length of fibers. It is not necessary to roughen the entire outer periphery of the casing 4 but only part of the outer periphery may be roughened where the resin molding is most likely to peel off the casing 4.

In the preferred embodiments, polyester, polystyrene or polycarbonate resin used for the casing shows good adhesion to epoxy resin so that the casing can be strongly bonded to the resin molding.

Further, by the provision of the roughened surface on the outer periphery of the casing, the resin can infiltrate into the the voids of the roughened surface or into between the fiber flocks so as to strengthen the adhesion between the casing and the molding layer.

CLAIMS

1. A capacitor comprising a plurality of inner casings having a shape retaining property; capacitor elements mounted in said respective inner casings; said inner casings being filled with an insulating fluid; said capacitor elements being connected electrically with one another to form an assembly; and an outer housing formed by encapsulating said inner casings with synthetic resin.

2. A capacitor comprising a plurality of inner casings having a shape retaining property; capacitor elements mounted in said respective inner casings; said inner casings being each filled with an insulating fluid and individually encapsulated with synthetic resin to seal said insulating fluid therein; said capacitor elements being connected electrically with one another to form an assembly; and an outer housing formed by encapsulating said inner casings with synthetic resin.

3. A capacitor as claimed in any of Claims 1 and 2, wherein said inner casing is made of polyester, polystyrene or polycarbonate resin.



4. A capacitor as claimed in any of Claims 1 and 2,
wherein at least part of the outer periphery of said
inner casing is roughened.

5 5. A capacitor as claimed in any of Claims 1 and 2,
wherein at least part of the outer periphery of said
inner casing is flocked with short fibers.

10 6. A capacitor as claimed in any of Claims 1 and 2,
wherein glass fiber material is wound around the
outer periphery of said inner casing.

7. A capacitor substantially as described with
reference to the drawings.

