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P/00/001
Section 29

AUSTRALIA
Patents Act 1990

PATENT REQUEST : STANDARD PATENT

The person identified below as the Applicant requests the grant of a patent to the person identified below as the Nominated Person, for an invention described in the accompanying standard complete specification.

Applicant:	BOWTHORPE INDUSTRIES LIMITED
Address:	Gatwick Road, Crawley, WEST SUSSEX, ENGLAND
Nominated Person:	BOWTHORPE INDUSTRIES LIMITED
Address:	Gatwick Road, Crawley, WEST SUSSEX, ENGLAND
Invention Title:	Electrical Surge Arrester/Diverter
Name of Actual Inventor:	Rodney Meredith Doone
Address for Service:	GRIFFITH HACK & CO 168 WALKER STREET NORTH SYDNEY NSW 2060
Attorney Code:	GH

BASIC CONVENTION APPLICATION DETAILS

Application No	Country	Country Code	Date of Application
8902633.0	Great Britain	GB	7 February 1989
8908740.7	Great Britain	GB	18 April 1989

DATED this 10th day of December 1992

BOWTHORPE INDUSTRIES LIMITED
By their Patent Attorney

GRIFFITH HACK & CO

AUSTRALIAN PATENT OFFICE

411/21220-A

FORM 1
REGULATION 9

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1973

APPLICATION FOR A PATENT

We BOWTHORPE INDUSTRIES LIMITED

of Gatwick Road, Crawley, WEST SUSSEX, ENGLAND

hereby apply for the grant of a Patent for an invention entitled:

ELECTRICAL SURGE ARRESTER/DIVERTER

which is described in the accompanying complete specification. This Application is a Convention Application and is based on the Applications numbered: 8902633.0 and 8908740.7 for a Patent or similar protection made in Great Britain on 7 February 1989 and 18 April 19879 respectively.

Our address for service is:

GRIFFITH HACK & CO
71 YORK STREET
SYDNEY NSW 2000

DATED this 7th day of February 1990

BOWTHORPE INDUSTRIES LIMITED
By their Patent Attorney

GRIFFITH HACK & CO

TO: THE COMMISSIONER OF PATENTS
COMMONWEALTH OF AUSTRALIA

8012932 07/02/90

3643A:rk

AU9049196

(12) PATENT ABRIDGMENT (11) Document No. AU-B-49196/90
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 633868

(54) Title
ELECTRICAL SURGE ARRESTER/DIVERTER

International Patent Classification(s)
(51)[4] H01T 004/06 H01T 004/04
(51)[5] H01C 007/12

(21) Application No. : 49196/90 (22) Application Date : 07.02.90

(30) Priority Data

(31) Number	(32) Date	(33) Country
8902633	07.02.89	GB UNITED KINGDOM
8908740	18.04.89	GB UNITED KINGDOM

(43) Publication Date : 16.08.90

(44) Publication Date of Accepted Application : 11.02.93

(71) Applicant(s)
BOWTHORPE INDUSTRIES LIMITED

(72) Inventor(s)
RODNEY MEREDITH DOONE

(74) Attorney or Agent
GRIFFITH HACK & CO., GPO Box 4164, SYDNEY NSW 2001

(56) Prior Art Documents
EP 280189
AU 608209 68133/87 H01T 4/04,4/06
AU 508717 32930/78 H01C 1/028,H01C 7/12

(57) Claim

1. A station class electrical surge arrester having a relatively high voltage rating of the order of 120kV to 525kV, said arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched distribution class surge arresters connected in parallel with each other by means of metallic conductors, each of said distribution class surge arresters having a relatively low voltage rating of the order of 24kV to 36kV and being of a gapless, high physical strength configuration including a rigid core comprising ceramic varistor blocks encased within a polymeric housing, and corona discharge suppression means provided at the top of the arrester and at the series interfaces of said plurality of series-connected stages.

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15. A station class high voltage electrical surge arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched, high physical strength, polymeric type, distribution class, low voltage surge arresters connected in parallel with each other, each said stage comprising an electrically conductive metallic mounting plate to which the plurality of distribution class low voltage surge arresters in the respective stage are mounted with uniform spacing apart from each other and a corona discharge suppression ring electrically connected to said mounting plate, there being a said corona discharge suppression ring at the top of the arrester, said polymeric type distribution class low voltage surge arresters each comprising a solid cylindrical core comprising varistor blocks and end terminals, said core being enclosed within a reinforcing shell and housed within a shedded polymeric housing, and the polymeric type distribution class low voltage surge arresters of each stage each being physically and electrically coupled at one end terminal thereof to the electrically conductive mounting plate of the respective stage and being upstanding therefrom for being physically and electrically coupled at the opposite end terminal to the electrically conductive mounting plate of the next stage in the series.

21. An electrical surge arrester for voltage applications ranging from 120kV to 525kV, the arrester comprising a plurality of stages, each comprising a

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plurality of surge arresters connected in parallel with one another through first and second metallic conductors arranged at respective ends of each stage, the first and second metallic conductors electrically connecting adjacent stages in series, each arrester including a core comprising varistor blocks and a polymeric housing, each parallel connected branch in each stage having a substantially similar impedance.

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PATENTS ACT 1952 Form 10

COMPLETE SPECIFICATION

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: BOWTHORPE INDUSTRIES LIMITED

Address of Applicant: Gatwick Road, Crawley, WEST SUSSEX, ENGLAND

Actual Inventor: Rodney Meredith Doone

Address for Service: GRIFFITH HACK & CO
71 YORK STREET
SYDNEY NSW 2000

Complete Specification for the invention entitled:

ELECTRICAL SURGE ARRESTER/DIVERTER

The following statement is a full description of this invention, including the best method of performing it known to us:-

21220-A:RPW:RK

3643A:rk

ELECTRICAL SURGE ARRESTER/DIVERTER

FIELD OF THE INVENTION

This invention concerns improvements in or relating to electrical surge arresters, also known as diverters, as used particularly (though not exclusively) in electrical power generation and distribution systems for the safe handling of atmospherically induced surges, arising from lightning strikes for example, and over-voltages caused by switching operations.

BACKGROUND OF THE INVENTION

Disclosed in our British Patent Application No. 2188199 is a polymer housed solid-state surge arrester which represents a considerable departure from the conventional porcelain housed arresters of old and is finding substantial commercial success. This arrester, which was developed from the arrester that is disclosed in our British Patent No. 2073965, comprises an elongate core constituted, preferably, by a distributed array of zinc oxide varistor blocks and electrically-conductive heat sink/spacer blocks in face-to-face contact between first and second terminal blocks and with the said blocks encased within a rigid

shell of reinforced rigid plastics material bonded to the peripheral surfaces of the blocks, and a shedded outer housing for said core comprising a sleeve of polymeric heat-shrink material or elastomeric material shrunk or released tightly onto said core with a weather-proof sealant between the core and the heat-shrink or elastomeric material or comprising in-situ moulded synthetic plastics material. The heat sink/spacer blocks are not essential to the arrester of our British Patent Application No. 2188199 abovementioned but provide advantageous voltage grading and thermal distribution effects within the arrester and are preferred for this reason.

As described in GB 2188199, the surge arrester therein disclosed has very considerable physical strength since its construction is based upon a core formed of ceramic varistor blocks and metallic heat-sink/spacer blocks encased within a reinforced plastics shell which is bonded to the surfaces of the blocks. The varistor and heat-sink/spacer blocks can even be adhesively secured in face-to-face contact by use of electrically conductive adhesives which adds to the physical strength of the core. Specifically mentioned in GB 2188199 is an improvement which can be obtained in the dressing of power distribution poles by virtue of using surge arresters of the construction

therein described; by virtue of the great physical strength of the surge arresters per se, stand-off support insulators, which were conventionally required to be provided in order to ensure that the conventional porcelain arrester was not physically loaded, can be dispensed with leading to a more cost effective, more readily installed, and aesthetically and environmentally more acceptable installation.

The polymeric surge arrester disclosed in GB 2188199 is inherently well adapted to utilization as a distribution class arrester, and the available sizes of varistor blocks and other limitations have dictated the continued utilization of large size porcelain housed arresters for station class and other high voltage applications. Such large porcelain arresters, wherein the arrester components are sealed within a shedded porcelain housing commonly with an inert gas filling and with elaborate blow-out mechanisms provided to protect the arrester against explosive destruction, are disadvantageous for a variety of reasons, namely they are expensive to manufacture and test, they are difficult to transport to their utilization site and are prone to damage both during transportation and in their subsequent erection, they are difficult to install and require the use of heavy lifting equipment and are prone to damage as

abovementioned, and they are inherently liable to the type of electrical problems that the polymeric arrester of GB 2188199 avoids (e.g. internal ionisation leading to degradation of internal components).

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a station class electrical surge arrester having a relatively high voltage rating of the order of 120kV to 525kV, said arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched distribution class surge arresters connected in parallel with each other by means of metallic conductors, each of said distribution class surge arresters having a relatively low voltage rating of the order of 24kV to 36kV and being of a gapless, high physical strength configuration including a rigid core comprising ceramic varistor blocks encased within a polymeric housing, and corona discharge suppression means provided at the top of the arrester and at the series interfaces of said plurality of series-connected stages.

According to another aspect of the present invention there is provided a station class high voltage electrical surge arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched, high physical strength, polymeric type, distribution class, low voltage surge arresters connected in parallel with each other, each said stage comprising an electrically conductive metallic mounting plate to which the plurality of distribution class low voltage surge arresters in the respective stage are mounted with uniform spacing apart from each other and a corona discharge suppression ring electrically connected to said mounting plate, there being a said corona discharge suppression ring at the top of the arrester, said polymeric type distribution class low voltage surge arresters each comprising a solid cylindrical core comprising varistor blocks and end

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terminals, said core being enclosed within a reinforcing shell and housed within a shedded polymeric housing, and the polymeric type distribution class low voltage surge arresters of each stage each being physically and electrically coupled at one end terminal thereof to the electrically conductive mounting plate of the respective stage and being upstanding therefrom for being physically and electrically coupled at the opposite end terminal to the electrically conductive mounting plate of the next stage in the series.

According to a further aspect of the present invention there is provided an electrical surge arrester for voltage applications ranging from 120kV to 525kV, the arrester comprising a plurality of stages, each comprising a plurality of surge arresters connected in parallel with one another through first and second metallic conductors arranged at respective ends of each stage, the first and second metallic conductors electrically connecting adjacent stages in series, each arrester including a core comprising varistor blocks and a polymeric housing, each parallel connected branch in each stage having a substantially similar impedance.

More particularly, and as described in GB 2188199, each of the relatively low voltage rating surge arresters might comprise an elongate cylindrical core, a polymeric sleeve of electrically insulating heat-shrink material having integral sheds shrunk onto said core with a weather-proof sealant between the core surface and the heat-shrunk sleeve so as to achieve a void free interface therebetween, and end caps capping the interface between the core and the sleeve at both ends thereof and with a weather-proof sealant between the end caps and the heat-shrunk sleeve so as to achieve a void free interface therebetween said core comprising a cylindrical terminal block at each end thereof and, between said terminal blocks, a plurality of cylindrical zinc oxide varistor blocks and a plurality of cylindrical aluminium heat-sink spacer blocks distributed to provide voltage grading throughout the length of the

AUSTRALIAN PATENT OFFICE LS

core with a predetermined core length arcing distance, said varistor blocks having metallized electrodes on end faces thereof held and preferably adhered by means of conductive adhesive in physical and electrical contact in each case with a contiguous end face of another varistor block or a respective one of the other type blocks, and said terminal blocks, varistor blocks and heat shrink spacer blocks being retained rigidly together in the core by means of a shell of glass reinforced cured rigid epoxy resin material desirably, but not essentially, bonded to the curved outer surfaces of the respective blocks without voids and gas entrapment and conveniently formed as a wrapping or winding upon the pre-assembled blocks of a pre-preg sheet or filamentary material.

Instead of a heat-shrink material outer housing, the relatively low voltage rating surge arresters could be formed as aforementioned with elastomeric outer housings released onto their cores or with in-situ moulded plastics housings. The end cap arrangement could be varied and the aluminium heat-sink/spacer blocks could be omitted or could be made of a different material. Variations could likewise be made to the rigid shell and in its method of formation without departure from the present invention, the essence of the invention being in its utilization of a

high strength structure rather than in the particular attainment of such high strength.

The following tabulation (Table 1) has been produced as the result of laboratory tests and demonstrates the number of series parallel networks of polymeric arresters that might be required in accordance with the teachings of the present invention to satisfy IEC 99-1 transmission line discharge classes. The tabulation is based on the use of 24 KV rated polymeric units.

TABLE 1

ARRESTER RATED VOLTAGE KV RMS	LINE DISCHARGE CLASS	NO OF 24KV UNITS IN PARALLEL	NO OF PARALLEL UNITS IN SERIES
120	3	3	5
192	3	3	8
240	4	4	10
360	4	4	15
432	4	4	18
456	5	5	19

The rated voltages of the units in parallel can be selected in order to meet the required voltage rating and there is no restriction to 24 KV units. However, experience dictates that unit ratings most conveniently will be 24 KV, 30KV or 36 KV and corresponding polymeric arresters are described in GB

2188199.

The series parallel configuration of the subject high voltage surge arrester may be achieved by use of mounting plates which serve to provide the parallel connections of the plural series arrester stages, the mounting plates desirably being generally circular and the unitary surge arresters making up each series stage being uniformly arranged equidistant from each other around the mounting plate so as to avoid undesirable non-uniformities in the electric fields permeating the arrester environment in use. In order to ensure that the voltage distribution of the series parallel network according to the present invention is within acceptable limits, the physical dimensions of the arrangement is of paramount importance, as will readily be appreciated by those possessed of relevant skills. It is considered that the dimensions of the arrangement will be determined by the system voltage and the relationship of electric field strength for a given arrangement diameter above an earthed plane. As mentioned above, it is desirable that the series parallel network of polymeric surge arresters be arranged in a circular arrangement and the following tabulation (Table 2) provides minimum arrangement diameters determined for maximum system voltages.

TABLE 2

SYSTEM VOLTAGE KV RMS	MINIMUM DIAMETER OF MOUNTING PLATE (CM)	MIN. DIAMETER OF CORONA RING TUBE
UP TO 220	25 CM	4.0 CM
UP TO 420	40 CM	6.5 CM
UP TO 525	60 CM	10.0 CM

A further important consideration is the elimination of corona discharge at the junction of each parallel network of the series, and the present invention proposes that this requirement be achieved by use of suitable corona rings provided at each junction. The diameter of the corona rings is determined by the junction voltage though, as a practical matter, it is convenient and effective to fit the same diameter corona rings to all junctions of a series parallel network. Table 2 above gives the minimum diameter of corona ring that should be used. The corona rings may be separate structures adapted to be secured to the periphery of the mounting plates, or alternatively and preferably may be formed integrally with the mounting plates. Described hereinafter in detail is an advantageous mounting plate cum corona ring configuration designed to encourage rainwater to flow

off the mounting plate surface, this configuration comprising a downwardly depending conical mounting plate formed at its outer circumference integrally with a radiussed corona ring.

The arrangement of the polymeric arresters in each stage of the overall arrester is advantageously rotationally offset from the arrangement of the polymeric arresters in its neighbouring stage or stages. By virtue of this arrangement, not only is the assembly of the overall arrester facilitated since the polymeric arresters in the various stages do not line up in the axial direction of the arrester and arrester-to-arrester couplings between the polymeric arresters are obviated in favour of arrester-to-mounting plate couplings only, but also the dissipation of heat from the polymeric arresters into the coupling plates is facilitated by virtue of the more distributed connections of the polymeric arresters to the mounting plates.

The mounting plates are thus seen as having the functions of (a) providing for the interconnection of the polymeric arresters, (b) providing a fixed electrostatic capacitance with the mounting plates of neighbouring stages which is advantageous as regards voltage grading throughout the overall arrester, and (c) providing a means of achieving thermal equilibrium

between the polymeric arresters in each stage so as to avoid any one of the plural arresters in any stage from overheating relative to its fellows in the respective stage and, by virtue of its inherent temperature-dependent resistance, giving rise to electrical imbalance in the respective stage. Where the corona ring is formed integrally with the mounting plate, the mounting plate also serves the additional function of providing the corona ring.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an exemplary polymeric surge arrester in accordance with the teachings of our British Patent Application No. 2188199 abovementioned;

Figure 2 shows a schematic side elevation view of a 120kV station class surge arrester constructed in accordance with the present invention as a series parallel network of a plurality of the surge arresters of Figure 1;

Figure 3 is a perspective view showing one stage of the surge arrester of Figure 2 and the mode of its

AUSTRALIAN PATENT OFFICE

connection to adjacent stages; and

Figures 4A and 4B are, respectively, plan and sectional side elevation views of a preferred mounting plate/corona ring configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, shown therein partly in sectional view and partly in side elevational view is an exemplary surge arrester 1 according to the teachings of GB 2188199 aforementioned. The surge arrester 1 comprises metal oxide varistor blocks 2, aluminium alloy heat sink/spacer blocks 3 and terminal blocks 4 structurally combined within a glass reinforced plastics shell 5 which is bonded to the outer cylindrical surfaces of the blocks 2,3 and 4. The varistor blocks 2, heat sink/spacer blocks 3, terminal blocks 4 and the glass reinforced plastics shell 5 constitute a unitary structural arrester core of great physical strength wherein the facing surfaces of the respective blocks are held and preferably are adhered by use of suitable conductive adhesive in face to face physical and electrical contact without air entrapment or bleed of plastics material. A heat-shrink sleeve 6 with integral sheds 7 of alternating greater and lesser diameter as shown and with the sheds desirably profiled to encourage shedding of surface moisture is shrunk about the arrester core

with inter-positioning of a fluid mastic material to ensure that the interface between the heat-shrink sleeve and the outer surface of the arrester core is free of voids or air entrapment and cannot be ingressed by moisture. Stainless steel end caps 8 are fitted to each end of the arrester with a silicone rubber or like sealant 9 filling the spaces between the interior of the end caps and the arrester core, and are retained by stainless steel terminal assemblies 10 which are screw-threadedly engaged with the terminal blocks 4 with seals 11 provided to prevent moisture ingress into the mated screw threads. It is to be noted that the skirt portions of the end caps 8 terminate on a level with the juncture between the respective terminal block 4 and the varistor block 2 in contact therewith to avoid the establishment of voltage gradients at these two positions which otherwise could detrimentally affect the intervening dielectric material.

The metal oxide varistor blocks 2 are commercially available from Meidensha for example and preferably will comprise zinc oxide non-linear resistor material. The heat-shrink sleeve 6 is available from Raychem and can be sealed against the glass reinforced plastics shell 5 by means of Raychem PPS 3022 sealant for example, and the same sealant

could be used for sealing the end caps 8 against the polymeric heat shrink material.

Varistor valve blocks are commonly available in cylindrical form with metallized aluminium contacts on their flat end faces and with their circumferential curved surface coated with an electrically insulating material. The heat sink/spacer elements are preferably formed of aluminium or an aluminium alloy as cylinders of the same diameter as the varistor valve blocks. The varistor valve blocks are provided in sufficient number to give the desired electrical resistance characteristics for the arrester, and the heat sinks/spacers are provided in sufficient number to give the arrester a sufficient length between its terminals to enable it to withstand its rated voltage without arcing and are distributed with the valve blocks so as to grade the voltage drop throughout the overall length of the arrester. A range of differently sized and differently rated distribution class surge arresters ranging from 6 KV to 36 KV for example can thus be constructed in accordance with the principles of Figure 1 simply by varying the number and the distribution of the varistor blocks 2 and aluminium heat sink/spacer blocks 3 so as to vary the length of the arrester, and further details in this respect may be found in our British Patent application

No. 2188199.

The reinforced plastics shell could be provided as a preformed tube within which the valve blocks, the terminal blocks and the heat sinks/spacers are assembled and potted with synthetic resin material, but it is preferred in accordance with the teachings of GB 2188199 to first assemble the valve blocks, the terminal blocks and the heat sinks/spacers in their desired array and then to wrap a pre-preg material comprising a resin impregnated textile fabric or mat of fibrous reinforcing material about the array with the array held in axial compression and thereafter cure the resin. As described in GB 2188199, the curing of the resin is preferably effected thermally under mould pressure so as to ensure that no voids or gaseous inclusions are present in the finished arrester. Alternatively it may be effected by the equivalent technique of helically wrapping the arrester core with its pre-preg wrapping in a heat-shrink tape (e.g. a Mylar tape), then heat-curing the resin and finally removing the tape.

Having thus formed the arrester core, the assembly to the core of the outer housing of heat-shrink material (sometimes referred to as heat-recoverable material) or mechanically released elastomeric material or in-situ moulded synthetic

resin material is a simple matter. Heat shrink sleeves with integral sheds which are suitable for this purpose are available from Raychem Limited and are the subject of Raychem's British Patents 1,530,994 and 1,530,995 the disclosures whereof are incorporated herein by way of reference. The heat-shrink material has desirable anti-tracking and other electrical properties which adapt it to utilization as a high voltage electrical insulator. A mastic sealant is utilized within the heat-shrink sleeve to ensure that the interface between the outer housing of heat shrink material and the reinforced plastics shell of the arrester core is void free and impervious to moisture penetration etc., and such mastic sealant is also available from Raychem Limited. As an alternative to heat-shrink material, an elastomeric material such as EPDM or silicone rubber for example could be used, the core being forced into the sleeve or the elastomer sleeve being mechanically expanded and introduced onto the core and then being released so as to elastically contract into tight engagement with the core surface, a weatherproof sealant preferably sealing the interface between the core and the elastomer sleeve. Synthetic rubber type EPDM sleeves with integral sheds are available from GEC-Henley which are suitable for this purpose. Alternatively, the outer housing could

be moulded onto the preformed arrester core.

As compared to an equivalent conventional porcelain housed surge arrester, a surge arrester constructed in accordance with the teachings of Figure 1 has the significant advantage of displaying a non-explosive failure mode and affords yet further advantages in that it is light weight, weighing only around half as much as a conventional arrester, and yet is very strong and robust and is resistant to damage through vandalism and improper handling and is unaffected by atmospheric pollutants and impervious to moisture ingress. It has only fairly recently been appreciated that some previously unexplained failures of conventional surge arresters could have resulted (and most probably did result) from the effects of ionization within the arrester producing a reducing atmosphere which increases the electrical conductivity of the varistor elements. These effects are exacerbated by the presence of moisture within the arrester, and by external atmospheric pollution which tends to increase the internal electrical stressing of the varistor elements. By avoiding the entrapment of gas or moisture the surge arrester of Figure 1 completely obviates these problems of conventional porcelain housed surge arresters. Moreover, the surge arrester of Figure 1 can be manufactured at lower cost

than a conventional porcelain housed surge arrester.

It will have been noted that the aluminium blocks 3 have been referred to in the foregoing as heat sinks/spacers. This is because the blocks 3 do in fact perform two essential functions. Firstly they serve as heat sinks within the arrester which operate to safeguard the structural integrity of the arrester core by provision of substantial thermal sinks at the faces of the varistor blocks 2, and secondly they serve to elongate the arrester so as to achieve the required arcing distance. In similar fashion, the glass reinforced plastics shell 5 serves the dual functions of providing for the structural integrity of the arrester core assembly and also serving as a thermal barrier. As will be appreciated by those skilled in the art, in the short-circuit failure mode of the arrester (and statistically every arrester is unavoidably liable to fail in this potentially most hazardous mode) which would last only for a fraction of a second until a circuit breaker trips in the associated power system, a very high transient current would flow through the arrester with the generation in consequence of temperatures of the order of 2000°C within the arrester core; the glass reinforced plastics shell serves to protect the polymeric outer housing of the arrester from this transient

temperature extreme thereby ensuring the structural integrity of the arrester throughout and after the duration of the transient. A conventional porcelain housed arrester would most likely shatter explosively as a result of such a transient condition.

The surge arrester of Figure 1 is achieving increasing penetration in the distribution class surge arrester market where, as described above, it has considerable advantages over a conventional porcelain housed arrester. However, as aforementioned, it has not been regarded as inherently suited to higher voltage applications where the porcelain housed arrester reigns supreme irrespective of its significant and widely recognized disadvantages. The present invention provides a breakthrough for the polymeric arrester of Figure 1, and for similarly constructed arresters within the ambit of our British Patent Application No. 2188199, into the higher voltage arrester market.

Referring to Figure 2 of the accompanying drawings, there is schematically shown therein an exemplary 120 KV station class surge arrester 20 in accordance with the present invention, the arrester comprising four 30 KV stages connected in series and each stage comprising three 30 KV arresters of the kind disclosed and claimed in our British Patent

Application No. 2188199 and exemplified by Figure 1 of the accompanying drawings connected in parallel. The four stages of the arrester are designated I, II, III and IV in Figure 2 and each stage comprises three polymeric arresters 21 mounted symmetrically and equidistantly from one another around the periphery of a circular frustoconical mounting plate 22 formed as shown in more detail in Figures 4A and 4B and of heavy gauge aluminium or aluminium alloy for example and dimensioned in accordance with Table 2. The arcing distance across each polymeric arrester 21, that is to say the vertical distance between its end caps, might be 380 mm (15 ins) in accordance with the teaching of Figure 2 of GB 2188199. A corona ring 23 formed integrally with the mounting plate 22 is provided at the top of each stage of the arrester 20 for the elimination of corona discharge effects, the provision of such corona rings in high voltage installations being per se known though not in the manner of the present invention. A line terminal (not shown) may be provided at the top of the arrester 20 and the assembled structure stands upon a base 25.

The precise form of the mounting plates 22 and of the corona rings 23 is susceptible to variation depending upon the intended application, for example as to whether the arrester is for indoor or outdoor

use. In indoor applications the mounting plates can simply be flat circular plates, but for outdoor applications there should for example be provision for drainage and to ensure that ice does not tend to build up within the arrester and in these situations annular mounting plates might be provided. The corona rings 23 could be formed integrally with the mounting plates or could be separate add-on structures.

Figures 4A and 4B show the presently preferred form of a combined mounting plate and corona ring as utilized in the series parallel surge arrester configuration shown in Figures 2 and 3. As shown the mounting plate 22 has an upwardly dished, frustoconical shape designed to facilitate run-off of rainwater when the arrester configuration is used outside in the weather and merges at its external periphery smoothly into the arcuate surface of the corona ring 23. Since the individual polymeric surge arresters of Figure 1 will, by virtue of the inclination of the mounting plate 22, be attached at each end to an inclined surface, appropriately shaped washers (which advantageously could be formed integrally with the mounting plate) will be utilized to ensure that the individual surge arresters mount to their mounting plates in a proper orientation.

The series parallel arrangement of Figures 2 and

3, and similar series parallel arrangements in accordance with the present invention which utilize a plurality of relatively low voltage rating polymeric arresters to form a relatively high voltage arrester, has many significant advantages amongst which are the following:

- any overall system voltage and energy requirement can be accommodated using a single unit rating
- the series parallel arrester can be assembled on site with manual labour only required and no lifting equipment needed
- the series parallel arrester can be transported to site as individual components to be assembled on site thereby avoiding the transportation difficulties previously encountered with conventional high voltage arresters
- the strength of the individual polymeric arresters virtually eliminates any risk of damage during transportation and erection
- manufacturing time, in terms of handling and testing, is reduced as compared with porcelain housed arresters
- type testing need only be carried out at highest duty (Class 5)
- problems of internal ionization leading to degradation of the varistor elements are

eliminated

- problems relating to system short circuit currents (i.e. pressure relief capability) are eliminated
- achieves more efficient cooling of varistor elements
- additional grading capacitances or other components are easily added at appropriate stages
- one size of varistor element can cover all system voltages and duties (most manufacturers currently use at least three different sizes)
- only simple test equipment is required during commissioning tests (i.e. a portable AC or DC test set with output as for a single unit arrester, namely 30 to 40 KV)
- low weight construction reduces the cost of supporting structures and the arrester can be mounted directly on the transformer tank or cable end sealing supporting structure
- can be easily uprated or downrated if system voltage is changed
- reduces customer's storage and stock problems in that only one size of arrester unit is required for all situations
- eliminates the risk of incorrect assembly

- service performance can easily be visually monitored in contrast to the situation with porcelain housed arresters
- earthquake response superior to porcelain arresters owing to the low mass and the rigid internal construction of the polymeric arrester units.

As will readily be appreciated by those possessed of relevant knowledge and experience, the above advantages which are not listed in any particular order represent a very substantial improvement over conventional high voltage arresters.

The present invention having been described by reference to a particular embodiment, it is to be appreciated that the invention is not restricted to the embodiment described and that many modifications and variations are possible without departure from the broad ambit of the invention which is to construct a high voltage surge arrester, such as a station class arrester, as a series parallel network comprising a plurality of polymer housed low voltage arresters such as are described and claimed in our British Patent Application No. 2188199 for example. Whilst it is preferred to make use of polymeric surge arresters in accordance with our British Patent Application No. 2188199 in the practice of the present invention, any

other polymeric surge arrester demonstrating similar properties of light weight and high physical strength could alternatively be used.

For example, whilst the polymeric surge arrester specifically described in our British Patent Application No. 2188199 is preferred for the purposes of the present invention on account of its outstanding physical strength properties coupled with superlative electrical performance, we are aware of the surge arrester proposal that is described in US Patent No. 4656555 and in accordance with which the varistor blocks are retained in face-to-face contact with each other and with terminal blocks by means of a filamentary winding carrying a synthetic resin material. Whilst we have to date conducted no tests to determine whether such a constructional technique as is described in US Patent No. 4656555 is capable of achieving a surge arrester having sufficient physical strength for the purposes of the present invention, it is conceivable that it does or could be modified to do so and accordingly it is regarded as being within the ambit of the present invention to construct a series parallel type surge arrester from polymeric surge arresters as described in US Patent No. 4656555 or substantially as therein described presuming that they have sufficient physical strength. We are aware

furthermore of a very recent proposal to construct a polymeric surge arrester as specifically described in our British Patent Application No. 2188199 except for the interpositioning of spring washers between the terminal blocks and the stack of varistor blocks and the provision of a thin tubular elastomeric membrane around the varistor block stack and between the varistor block stack and the encasing resin-impregnated glass fibre wrapping and, whilst we have to date conducted no tests on such an arrester construction it would be possible to use such an arrester in the construction of a series parallel arrester configuration in accordance with the present invention so long as sufficient physical strength in the arrester could be attained.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A station class electrical surge arrester having a relatively high voltage rating of the order of 120kV to 525kV, said arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched distribution class surge arresters connected in parallel with each other by means of metallic conductors, each of said distribution class surge arresters having a relatively low voltage rating of the order of 24kV to 36kV and being of a gapless, high physical strength configuration including a rigid core comprising ceramic varistor blocks encased within a polymeric housing, and corona discharge suppression means provided at the top of the arrester and at the series interfaces of said plurality of series-connected stages.

2. A station class electrical surge arrester as claimed in claim 1, wherein said distribution class surge arresters each have an elongate core comprising varistor blocks and terminal blocks encased within a rigid shell of reinforced plastic material, and said core is encased within a shedded polymeric outer

AUSTRALIAN PATENT OFFICE

housing.

3. A station class electrical surge arrester as claimed in claim 1, wherein said distribution class surge arresters each have an elongate core comprising varistor blocks and terminal blocks encased within a rigid shell of reinforced plastic material which is bonded to the peripheral surfaces of at least the terminal blocks, and said core is encased within a shedded polymeric outer housing.

4. A station class electrical surge arrester as claimed in claim 2 or 3, wherein said rigid shell of reinforced plastic material comprises a filamentary or sheet carrier of uncured plastic material wound or wrapped about said blocks and subsequently cured.

5. A station class electrical surge arrester as claimed in any one of claims 1 to 4, wherein said varistor blocks are metal oxide varistor blocks.

6. A station class electrical surge arrester as claimed in claim 5, wherein said metal oxide is zinc oxide.

7. A station class electrical surge arrester as

AUSTRALIAN PATENT OFFICE

claimed in any one of claims 1 to 6, wherein the cores of said distribution class surge arresters further comprise heat sink/spacer blocks distributed with the varistor blocks.

8. A station class electrical surge arrester as claimed in any one of claims 1 to 7, wherein said polymeric housing comprises heat-shrink material shrunk onto said core, or elastomeric material released onto said core, or plastic material molded in situ on said core.

9. A station class electrical surge arrester as claimed in any one of claims 1 to 8, wherein each of said series-connected stages comprises a plurality of said distribution class surge arresters mounted electrically in parallel with each other between metallic mounting plates disposed generally parallel to each other.

10. A station class electrical surge arrester as claimed in claim 9, wherein said mounting plates are circular and the plurality of distribution class surge arresters in each stage are uniformly spaced apart from each other circumferentially of said mounting plates.

AUSTRALIAN PATENT OFFICE

11. A station class electrical surge arrester as claimed in claim 9 or 10, wherein the plurality of distribution class surge arresters in each stage are circumferentially offset with respect to the plurality of distribution class surge arresters of the or each next adjoining stage.

12. A station class electrical surge arrester as claimed in claim 9 or 10 or 11, wherein said corona discharge suppression means are formed integrally with the mounting plates.

13. A station class electrical surge arrester as claimed in claim 12, wherein the mounting plates have an upwardly dished frustoconical shape for facilitating run-off of rainwater and merging at its external periphery into an arcuate surface defining a corona discharge suppression ring.

14. A station class electrical surge arrester as claimed in any one of claims 9 to 13 wherein said mounting plates are annular to facilitate drainage of rainwater from the arrester and to discourage the build-up of ice within the arrester.

15. A station class high voltage electrical surge

AUSTRALIAN PATENT OFFICE

arrester comprising a plurality of series-connected stages each of which comprises a plurality of electrically matched, high physical strength, polymeric type, distribution class, low voltage surge arresters connected in parallel with each other, each said stage comprising an electrically conductive metallic mounting plate to which the plurality of distribution class low voltage surge arresters in the respective stage are mounted with uniform spacing apart from each other and a corona discharge suppression ring electrically connected to said mounting plate, there being a said corona discharge suppression ring at the top of the arrester, said polymeric type distribution class low voltage surge arresters each comprising a solid cylindrical core comprising varistor blocks and end terminals, said core being enclosed within a reinforcing shell and housed within a shedded polymeric housing, and the polymeric type distribution class low voltage surge arresters of each stage each being physically and electrically coupled at one end terminal thereof to the electrically conductive mounting plate of the respective stage and being upstanding therefrom for being physically and electrically coupled at the opposite end terminal to the electrically conductive mounting plate of the next stage in the series.

AUSTRALIAN PATENT OFFICE

16. A station class surge arrester as claimed in claim 15, wherein said corona discharge suppression ring is formed integrally with said mounting plate.

17. A station class surge arrester as claimed in claim 15 or 16, wherein the mounting plates have an upwardly dished frustoconical shape for facilitating run-off of rainwater and merging at its external periphery into an arcuate surface defining a corona discharge suppression ring.

18. A station class surge arrester as claimed in any one of claims 15 to 17, wherein said mounting plates are annular to facilitate drainage of rainwater from the arrester and to discourage the build-up of ice within the arrester.

19. A station class surge arrester as claimed in any one of claims 15 to 18, wherein the voltage rating of the arrester is of the order of 120kV to 525kV, while the voltage rating of the constituent distribution class surge arresters is only of the order of 24kV to 36kV.

20. A station class electrical surge arrester substantially as herein described with reference to

AUSTRALIAN PATENT OFFICE

Figures 2 to 4B of the accompanying drawings.

21. An electrical surge arrester for voltage applications ranging from 120kV to 525kV, the arrester comprising a plurality of stages, each comprising a plurality of surge arresters connected in parallel with one another through first and second metallic conductors arranged at respective ends of each stage, the first and second metallic conductors electrically connecting adjacent stages in series, each arrester including a core comprising varistor blocks and a polymeric housing, each parallel connected branch in each stage having a substantially similar impedance.

22. An electrical surge arrester as claimed in claim 21 wherein the first and second metallic conductors have effectively zero resistance relative to the arresters.

23. An electrical surge arrester as claimed in claim 21 or 22 wherein each arrester is of a distribution class having a relative low voltage rating of the order of 24kV to 36kV and is of a gapless, high physical strength configuration including a rigid core.

24. An electrical surge arrester as claimed in any one of claims 21 to 23 wherein each of the first and second metallic conductors comprise a corona discharge suppression means.

25. An electrical surge arrester as claimed in any one of claims 21 to 24 wherein each metallic conductor comprises a plate to which arresters from adjacent stages are connected.

26. An electrical surge arrester as claimed in claim 25 wherein each arrester in one stage is connected to the plate at each end whereby the arresters are uniformly spaced apart around a central axis of each plate and equidistant therefrom.

27. An electrical surge arrester as claimed in claim 26 wherein each metallic conductor comprises a dish shaped member having a hub portion to which the arresters are arranged to be connected and a rim portion which forms the corona discharge suppression means.

AUSTRALIAN PATENT OFFICE

28. An electrical surge arrester as claimed in claim 27 wherein the hub is frustoconical in shape.

29. An electrical surge arrester as claimed in claim 28 wherein a lip of the rim is directed inwardly to the central axis of its plate.

30. An electrical surge arrester as claimed in claim 27 wherein the metallic conductor is a part toroidal shaped shell with an open lower surface.

31. An electrical surge arrester as claimed in claim 29 wherein the rim is arcuate in shape and substantially symmetrical about a central apex.

32. An electrical surge arrester as claimed in claim 31 wherein each metal plate is annular with the hub encircling a central hole.

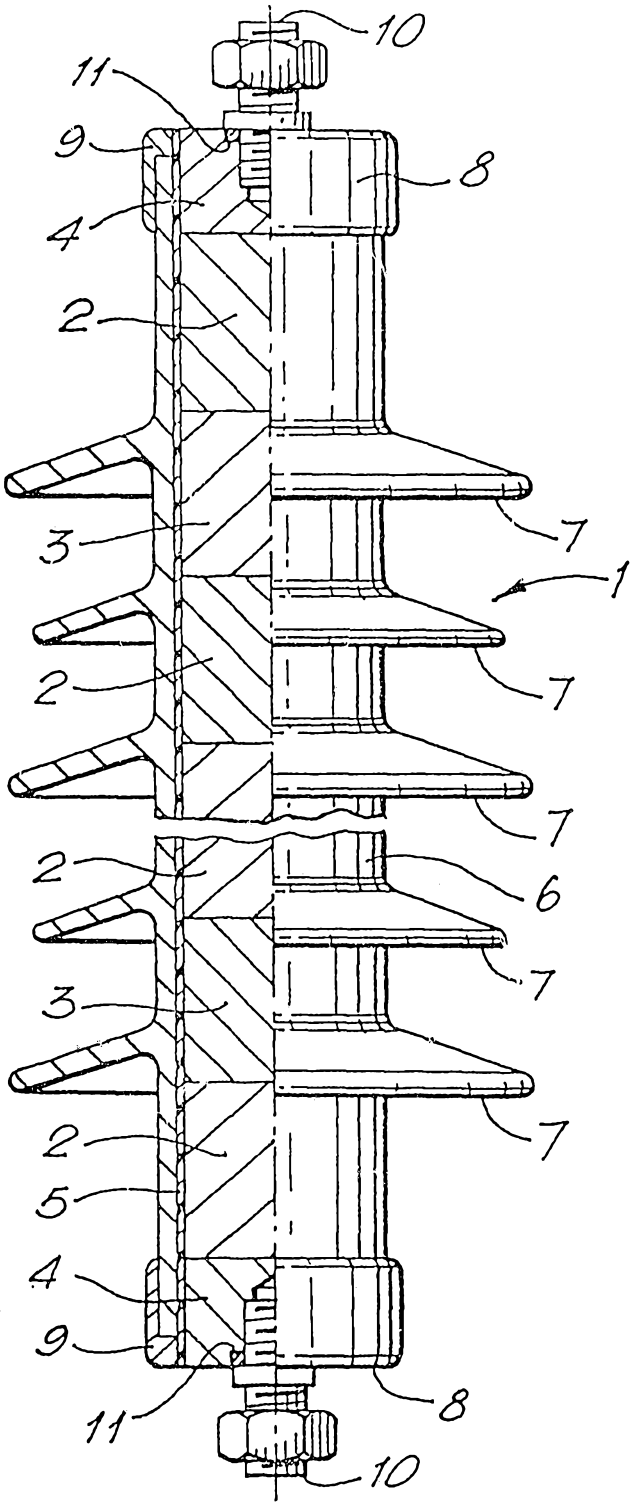
33. An electrical surge arrester as claimed in any one of claims 25 to 32 wherein each metal plate is provided with an array of mounting locations arranged in a symmetrical configuration around the metal plates central axis.

Dated this 10th day of November 1992

BOWTHORPE INDUSTRIES LIMITED
By their Patent Attorney
GRIFFITH HACK & CO.

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FIG.1.



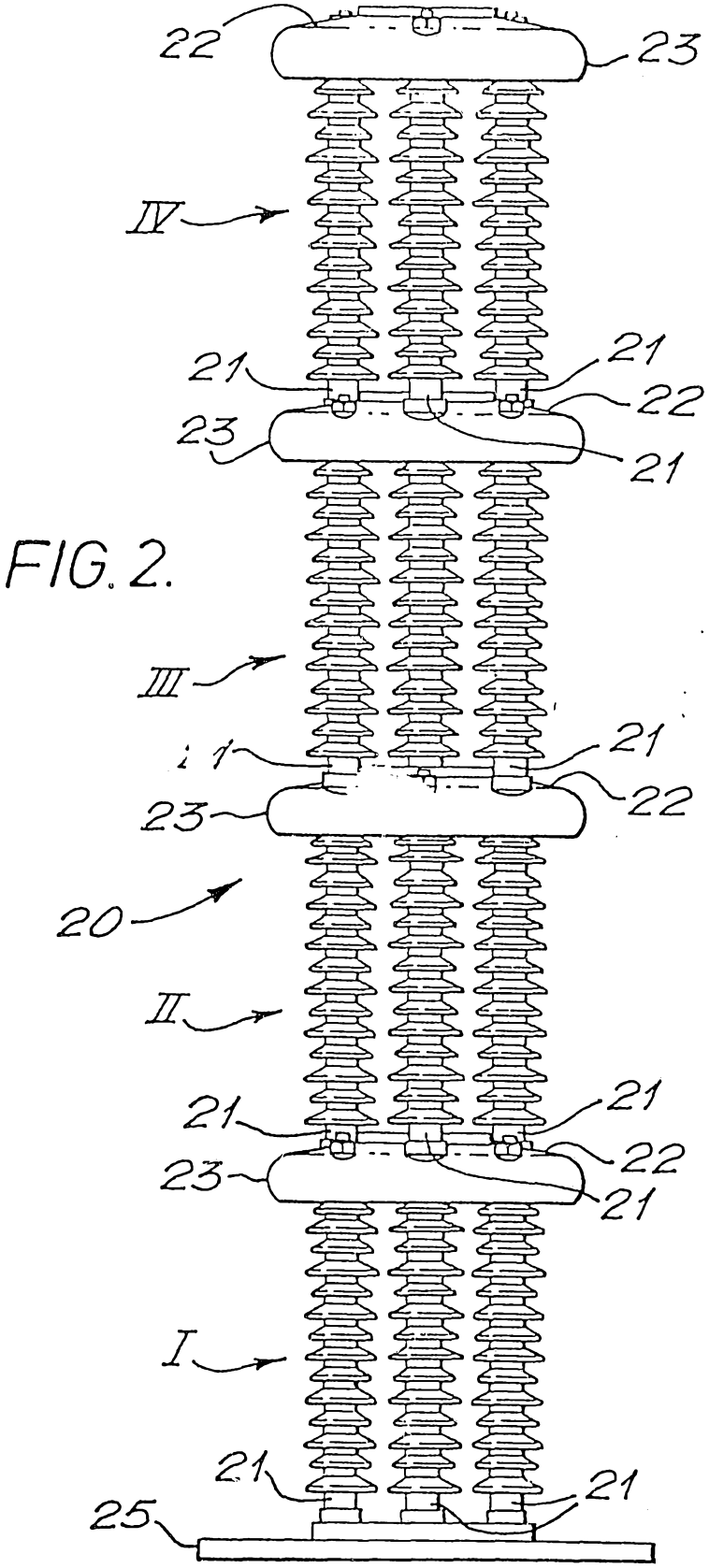


FIG. 2.

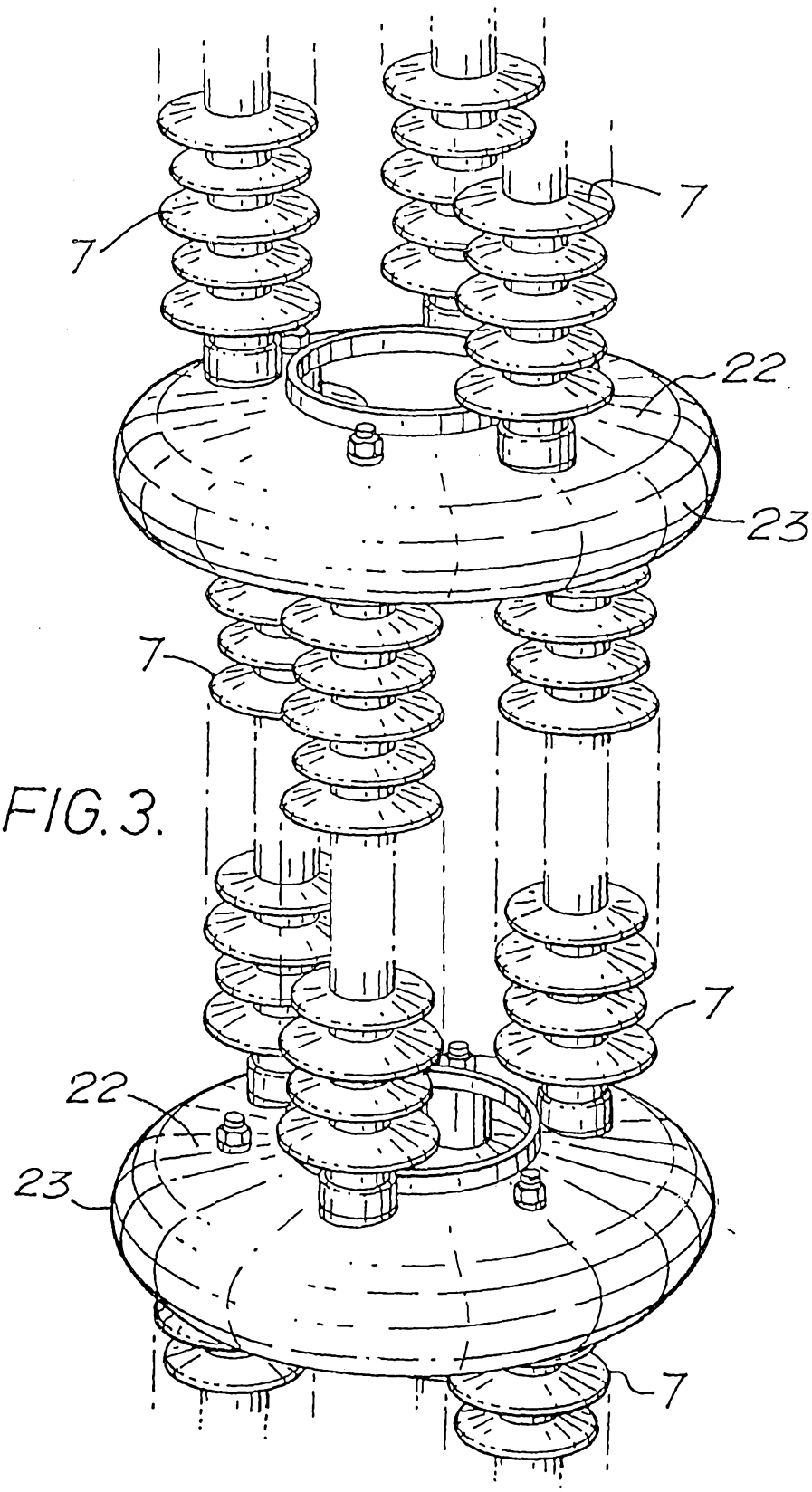


FIG. 3.

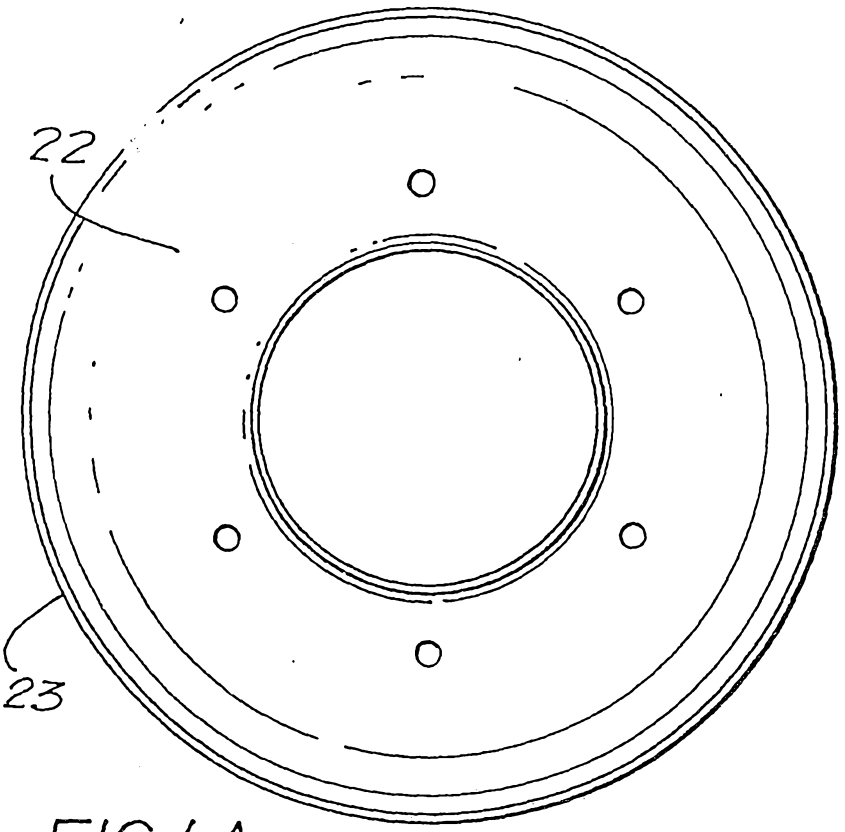


FIG. 4A.

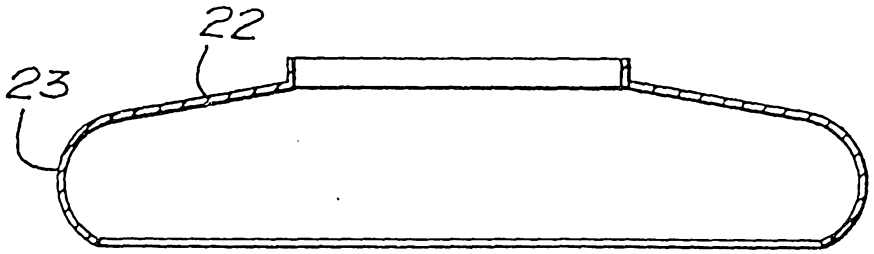


FIG. 4B.