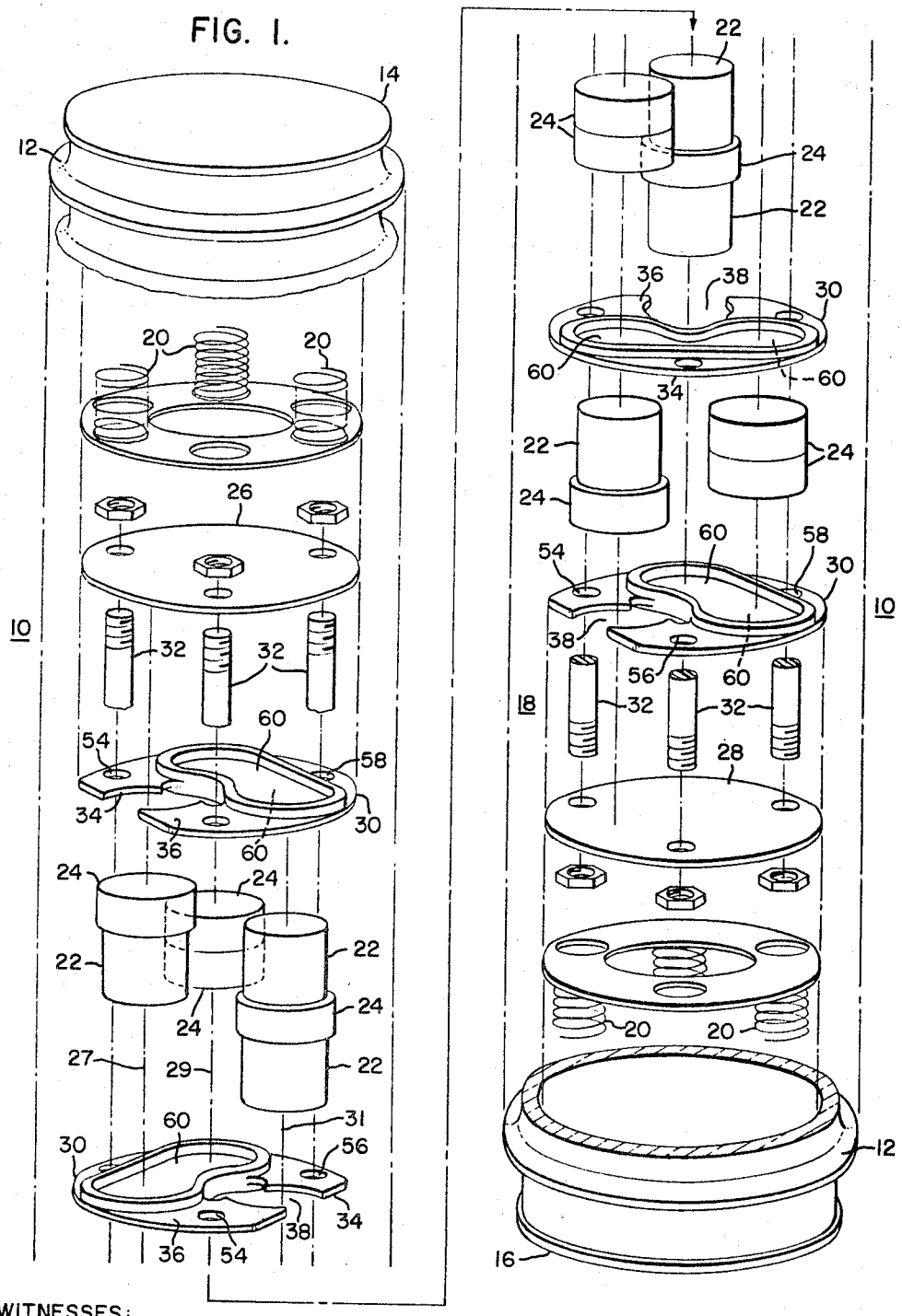
Nov. 19, 1968 R. E. KENNON ETAL 3,412,273

HIGH VOLTAGE LIGHTNING ARRESTER HAVING A PLURALITY OF ARRESTER ELEMENTS

Filed Oct. 28, 1964

2 Sheets-Sheet 1

FIG. 1.



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2 Sheets-Sheet 2

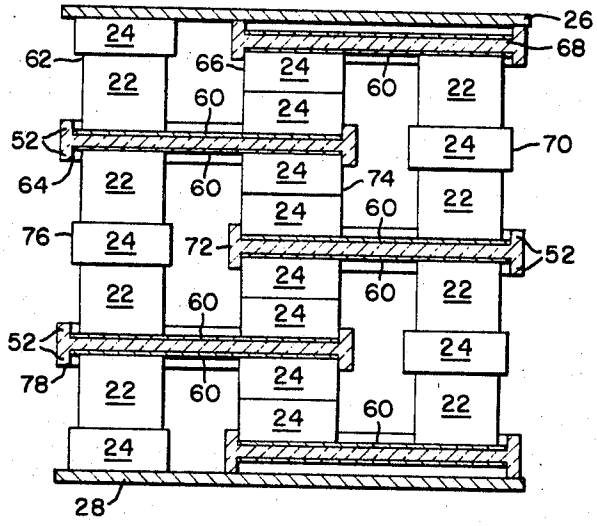


FIG. 2.

FIG. 3.

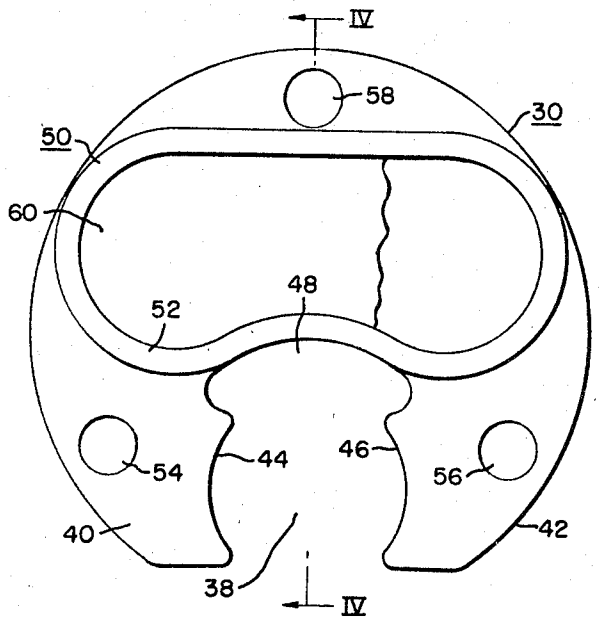
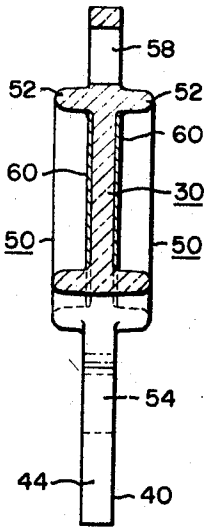


FIG. 4.



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3,412,273

HIGH VOLTAGE LIGHTNING ARRESTER HAVING A PLURALITY OF ARRESTER ELEMENTS

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ABSTRACT OF THE DISCLOSURE

A high voltage lightning arrester having a plurality of columns of arrester elements divided into sections by insulating plates which also support the columns.

The present invention relates to lightning arresters, and more particularly to arresters adapted for servicing high voltage lines or equipment.

In the manufacture of high voltage lightning arresters, it is now common practice to provide a single series circuit of arrester elements through multiple (usually three and sometimes two, but other numbers are feasible) physical columns of the elements. In this manner, the required total arrester voltage rating can be achieved while physical height of the device is held sufficiently low to provide convenient use of the device.

The arrester elements must be physically supported in the columnar arrangement while intercolumnar connections are provided to establish a series arrester circuit through the elements. Sufficient insulation level (through gas and other insulative material) must exist between all physically proximate circuit points subject to any potential difference.

One basic structural approach is that in which a plurality of horizontally disposed insulative plates are interposed and spaced along the height of the arrester element columns. Physical support of the individual arrester elements is provided by the plates which in turn can be mechanically interconnected by means of insulative tie rods and thereby fixed in relation to the arrester housing. Intercolumnar connections between the arrester elements are made adjacent the vertically spaced insulative plates to provide a series arrester circuit which spirals along the arrester height.

It is desirable that the assembly of plates and arrester elements be characterized with mechanical strength and relatively minimum height as well as with manufacturing facility and economy including minimal usage of insulative materials consistent with required insulation levels. With respect to usage of insulative material, it is known that too much material in the wrong places can be detrimental to arrester operation since voltage gradients can be established across two materials of different dielectric constants that will cause ionization leading to insulation failure or radio interference. A primary determinant of these manufacturing and end product features is the structure of the insulative plates and the manner in which cooperation is provided among the plates and the arrester elements.

In accordance with the principles of the present invention, there is provided in an arrester device a multiple column assembly of arrester elements characterized with the foregoing as well as other structural and manufacturing features. The assembly comprises a plurality of suitable valve blocks and arrester gap units arranged in at least three physical columns and interconnected in a series circuit with insulative plates horizontally disposed at spaced levels along the assembly height to provide mechanical support and required insulation between

physically proximate but electrically diverse circuit points. Each physical column is divided by the plates into a plurality of sections, with each section having top and bottom vertical support provided by the bottom and top sides of respective associated plates. In turn, top and bottom sides of each plate are provided with insulative wall means projecting in the vertical direction so as to provide a creepage barrier and, if desired, to provide side support for the arrester elements in adjacent sections of all but one of the columns. Each plate also has at least one opening preferably formed by a pair of arms in the plate solid plane to provide side support for arrester elements in a "transfer" section of the column.

It is therefore an object of the invention to provide a novel high voltage arrester in which a multiple column assembly of arrester elements is efficiently organized for achieving relatively minimal or comparatively reduced arrester height.

Another object of the invention is to provide a novel high voltage arrester in which a multiple column assembly of arrester elements is arranged for manufacturing facility and economy.

An additional object of the invention is to provide a novel high voltage arrester in which a multiple column assembly of arrester elements is characterized with good mechanical strength.

It is a further object of the invention to provide a novel high voltage arrester in which a multiple column assembly of arrester elements is arranged with relatively minimal use of insulative material.

It is an additional object of the invention to provide a novel high voltage arrester in which a multiple column assembly of arrester elements is provided with relatively optimal insulative separation between circuit points subject to relatively large potential drop during arrester operation.

These and other objects of the invention will become more apparent upon consideration of the following detailed description along with the attached drawings, in which:

FIGURE 1 shows an exploded perspective view of an arrester constructed in accordance with the principles of the invention and having parts thereof broken away;

FIG. 2 shows a schematic diagram of an arrester circuit formed within the device of FIG. 1;

FIG. 3 shows a top view of an insulative plate used in an arrester element assembly of the device of FIG. 1; and

FIG. 4 shows a cross-section of the insulative plate taken along the reference line IV—IV of FIG. 3.

More specifically, there is shown in FIG. 1 a high voltage lightning arrester **10** constructed in accordance with the principles of the invention for connection, alone or in series with additional identical arresters or arrester units, between a high voltage conductor and ground. The arrester **10** includes an insulative or porcelain housing **12** filled with an insulative atmosphere such as dry nitrogen and having end terminal plates **14** and **16** disposed at the top and bottom thereof and in sealed securance therewith. Within the housing **12**, an assembly **18** of arrester elements is supported between the terminal plates **14** and **16**. Preferably, coil springs **20** hold the assembly **18** in compression to provide stable mechanical support for the assembly **18** during shipment and during use and to maintain reliable electrical connections throughout the arrester circuit provided by the assembly **18**.

The arrester circuit comprises a suitable plurality of arrester elements or suitable gap units **22** and suitable valve blocks **24** connected in a single series electrical circuit physically disposed in three columns. The number and the voltage rating of the elements **22** and **24** are de-

terminative of the overall arrester voltage rating. It is apparent that the pluralistic columnar arrangement of elements **22** and **24** leads to height conservation for the arrester device **10**.

Each gap unit **22** can for example comprise the magnetic blowout gap structure disclosed in a copending application Ser. No. 405,945, filed by J. Osterhout on Oct. 23, 1964 and assigned to the present assignee. To facilitate arrester discharge current flow while providing for gap interruption of power follow current, each block **24** is characterized with resistance which decreases with increasing voltage. To obtain this variant resistance property, each block **24** can be formed from granular silicon carbide with a suitable binder. As is well known, end surfaces of the blocks **24** can be suitably metallized (not shown) to provide for circuit connections.

The assembly **18** includes top and bottom connector plates **26** and **28** between which the arrester elements **22** and **24** are supported in the columns by means of insulative (for example porcelain) plates **30** which are tied together to the connector plates **26** and **28** by means of insulative tie rods **32**. The insulative plates **30** generally have an outer contour which encompasses that of the arrester element columns and further divide each column into vertical sections so that the arrester circuit can be formed "spirally" through the sections from column to column along the assembly height.

Generally, each section of each column forms a series circuit segment and is supported at its top by means of a bottom side **34** of an adjacent plate **30** and at its bottom by means of a top side **36** of an adjacent plate. Two exceptions are the topmost and bottommost sections which receive top and bottom support respectively by the end connector plates **26** and **28**.

To provide such mechanical support throughout the assembly **18** while providing for an intercolumnar series arrester circuit, each plate **30** is provided with an opening **38** (FIG. 3) preferably formed by a pair of arms **40** and **42** in the plane of the plate **30**. The ends of the arms **40** and **42** are provided with accurate indents **44** and **46** between which there is horizontally supported in the opening **38** an element or block **24** of a "transfer" section of one of the columns. Preferably, an open space **48** is provided radially inwardly from the opening **38** for the purpose of providing the necessary single dielectric constant gaseous insulation and adequately long creepage path between columns.

The term "transfer" is used to denote a columnar section which provides a circuit path to a new higher or lower insulative plate level in the assembly **18**. Accordingly, each transfer section is provided with midpoint support by the arms **40** and **42** of an intermediately located plate **30** as well as top and bottom support by top and bottom plates **30** located at the ends of the transfer section. In this instance, every alternate columnar section in the series circuit path is a transfer section.

In addition, each plate **30** is provided with vertically projecting wall means **50** on its top side **36** and preferably identical vertical projecting wall means **50** on its bottom side **34**. The wall means **50** is in the form of a single vertically projecting wall **52** which circumscribes the end arrester elements **22** or **24** of a pair of sections vertically supported therewithin. If desired, side support can thus be provided for the ends of each section, but primarily a barrier is provided against creepage between end elements aligned with each other in the same column and disposed in spaced relation on opposite sides of the plate **30**. Further, as can be observed in FIG. 1, the plates **30** are successively rotated from one another by 120° so that the spiraling intercolumnar circuit path can be formed as described.

To provide for assembly securance by means of the tie rods **32**, each plate **30** is also provided with openings **54** and **56** in the plate arms **40** and **42** and an opening **58** extended through the solid plane of the plate radially outwardly of the creepage wall **52**. When the insulative tie rods **32** are extended through the aligned plate openings **54**, **56** and **58** of the various plates **30**, side support is provided for the plates **30** against horizontal dislocation from the assembly **18**. Vertical support is provided as previously described, namely by means of compressive force applied among the arrester elements **22** and **24** and the plates **30** by means of the coil springs **20**.

The various arrester element columnar sections are cross connected in the overall arrester series circuit by suitable means, preferably by conductive metallic plates **60** respectively disposed within the plate walls **52** against the bottom side **34** or the top side **36** of each insulative plate **30**. Preferably, the portion of the horizontal plate surface within the wall **52** on each plate side **34** or **36** is metallized or sprayed with conductive paint to establish fixed capacitance between the two plate sides **34** and **36**. Such capacitance electrically parallels portions of the arrester circuit as more fully described in U.S. Patent No. 2,542,805, entitled, "Lightning Arrester," issued to A. J. Fink on Feb. 20, 1951, and assigned to the present assignee.

The purpose of the built-in capacitance is to produce substantially uniform voltage gradient across the arrester circuit. If the dielectric constant of the plate material is relatively high, it is not necessary to use auxiliary capacitors to supplement the indicated capacitance effect. For the lower frequency components of arrester voltage it is normally necessary to use suitably connected nonlinear resistors (not shown) for voltage grading purposes.

In FIG. 2, there is schematically illustrated a sample arrangement for the gaps **22** and the blocks **24** in the various sections of the columns. In this schematic, the reference characters **22** and **24** are used for the gaps and the blocks and the reference character **52** represents the insulation provided by the plate walls **52** against creepage. It is assumed in this example that an overall arrester rating of 48 kv. is specified and that the gaps are rated at 6 kv. and the blocks are rated at 4 kv. Further, to facilitate illustration, the columns of aligned elements in FIG. 2 do not correspond with the physical columns in FIG. 1.

A first columnar section **62** comprises a block **24** and a gap **22** supported at its top against top connector plate **26** and at its bottom within the top wall **52** of an insulative plate **30** indicated in this schematic by the reference character **64**. The block **24** in the section **62** is operable at a potential of 48 kv.

Another section **66** is serially connected with the section **62** by means of a connector **60** and it also is supported within the top wall **52** of the insulative plate **64**. The section **66** comprises a pair of blocks **24** which are operable at a potential of 42 kv. because of a 6 kv. voltage drop in the gap **22** of the section **62**. A topmost insulative plate **68** is disposed on the section **66** with the topmost block **24** of the section **66** disposed within the bottom wall **52** of the plate **68**. A connector **60** extends from the section **66** to the next columnar section which is a transfer section **70**.

The section **70** cooperates with the section **66** in supporting the plate **68** and it includes a pair of gaps **22** separated by a block **24** (operable at 36 kv.) with the block **24** side supported by the arms **40** and **42** of the plate **64**. The transfer section **70** is provided with bottom support by another insulative plate **72** within the top wall **52** thereof.

Another connector **60** within the top wall **52** of the plate **72** establishes connection between the transfer section **70** to another section **74** comprising a pair of blocks (operable at 30 kv.). The section **74** and another transfer section **76** support the plate **64**, and the transfer section **76** in turn is supported by another plate **78**. The arrester circuit is thus continued to the bottom connector plate **28** (operable at 0 kv.) at the bottom of the assembly **18**. The gaps **22** and blocks **24** and plates **30** mutually support one another as indicated while a series intercolumnar arrester circuit is established with adequate but not excessive placement of insulation.

The assembly **18** is formed with facility by layering insulative plates **30**, blocks **24** and gaps **22** yet it is clear that the support relationships within the assembly **18** provide excellent mechanical strength. Further, the structural organization of the plates **30** is such that required insulation is provided while economy in use of insulative material is achieved and while overall arrester height is relatively conserved.

The foregoing description has been presented only to illustrate the principles of the invention. Accordingly, it is desired that the invention be not limited to the embodiment described, but, rather, that it be accorded an interpretation consistent with the scope and spirit of its broad principles.

What is claimed is:

1. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in a plurality of vertical columns within said housing, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported between a pair of said plates, an opening in each of said plates through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, and means for connecting said sections into a series arrester circuit.

2. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in a plurality of vertical columns within said housing, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections with each section supported between a pair of said plates, said sections including transfer sections each of which includes some of said arrester elements of which at least one is a gap unit, an opening in each of said plates through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, and means for connecting said sections into a series arrester circuit.

3. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in three vertical columns within said housing, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections with each section supported between a pair of said plates, said sections including transfer sections each of which contains some of said arrester elements of which at least one is a gap unit, an opening in each of said plates through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, means connecting said sections into a series arrester circuit, every alternate section in said series circuit being a transfer section.

4. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in a plurality of vertical columns within said housing, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported between a pair of said plates, an opening in each of said plates through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, a vertically projecting creepage barrier wall disposed on each side of said plates and circumscribing the end elements of superjacent and subjacent sections which are supported against said plate sides, and means for connecting said sections into a series arrester circuit.

5. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in a plurality of vertical columns within said housing, a plurality of insulative plates interposed in vetrically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported between a pair of said plates, each plate having a pair of arms extending in the solid plane thereof, an opening provided between the ends of said arms through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, and means for connecting said sections into a series arrester circuit.

6. A lightning arrester comprising an insulative housing, a plurality of arrester elements disposed in a plurality of vertical columns within said housing, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported between a pair of said plates, each plate having a pair of arms extending in the solid plane thereof, an indent in the outer end of each of said arms with an opening therebetween through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, and another opening between said arms inwardly of the end opening to provide single dielectric constant gaseous insulation and an adequately long creepage path between said columns, creepage barrier wall means disposed on each side of said plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, and means for connecting said sections into a series arrester circuit.

7. A lightning arrester comprising an insulative housing, an assembly of arrester elements disposed within said housing, said arrester elements arranged in a plurality of vertical columns, a top end connector plate and a bottom end connector plate for said assembly with said elements disposed in said columns therebetween, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported adjacent its top and bottom ends against a pair of said plates, an opening in each of said insulative plates through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said insulative plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, means for connecting said sections into a series arrester circuit, and a plurality of insulative tie rods extending between said end connector plates and through respective tie rod openings in each of said insulative plates to tie said assembly together.

8. A lightning arrester comprising an insulative housing, an assembly of arrester elements disposed within said housing, said arrester elements arranged in a plurality of vertical columns, a top end connector plate and a bottom end connector plate for said assembly with said elements disposed in said columns therebetween, a plurality of insulative plates interposed in vertically spaced relation in said columns to divide said columns into a plurality of vertical columnar sections including transfer sections with each section supported adjacent its top and bottom ends against a pair of said plates, each plate having a pair of arms extending in the solid plane thereof, an opening pro-

vided between the ends of said arms through which a transfer section extends in side supported relation from a next higher plate level to a next lower plate level, creepage barrier wall means disposed on each side of said insulative plates and generally about the end elements of superjacent and subjacent sections which are supported against said plate sides, means for connecting said sections into a series arrester circuit, and a plurality of insulative tie rods extending between said end connector plates and through respective tie rod openings in each of said insulative plates to tie said assembly together, said tie rod openings including at least one opening in each of said insulative plate arms and another opening disposed horizontally outwardly of said wall means.

9. A lightning arrester as set forth in claim 8 wherein said insulative plate wall means comprises a vertically extending wall circumscribing the adjacent section end elements.

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