United States Patent

Charamel et al.

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[54] HIGH-VOLTAGE DISCONNECTING SWITCH WITH SLIDING CONTACT

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[51] **Int. Cl.** **H01h 15/02**

[58] **Field of Search** ..... 200/11 TC, 48 R, 16 R, 148 F, 200/6 A, 16 B, 163

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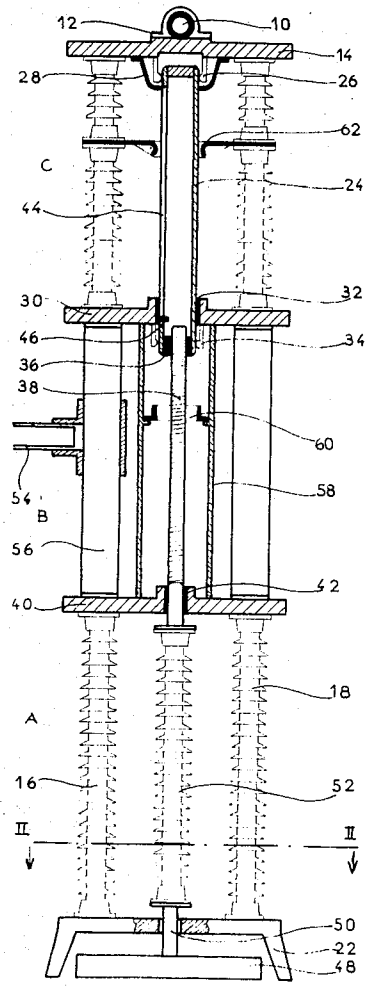
[57] **ABSTRACT**

A high-voltage disconnecting switch for establishing an electrical connection between two vertically spaced contacts by means of a movable contact capable of being moved in a vertical translation by a drive mechanism which comprises a threaded drive rod cooperating with an internally threaded element wherein the fixed moving contacts as well as the drive rod are axially arranged in a supporting structure comprising a plurality of superimposed sections defined by transverse plates, the plates of the upper section supporting the fixed contacts and providing guide means for the moving contact.

17 Claims, 6 Drawing Figures



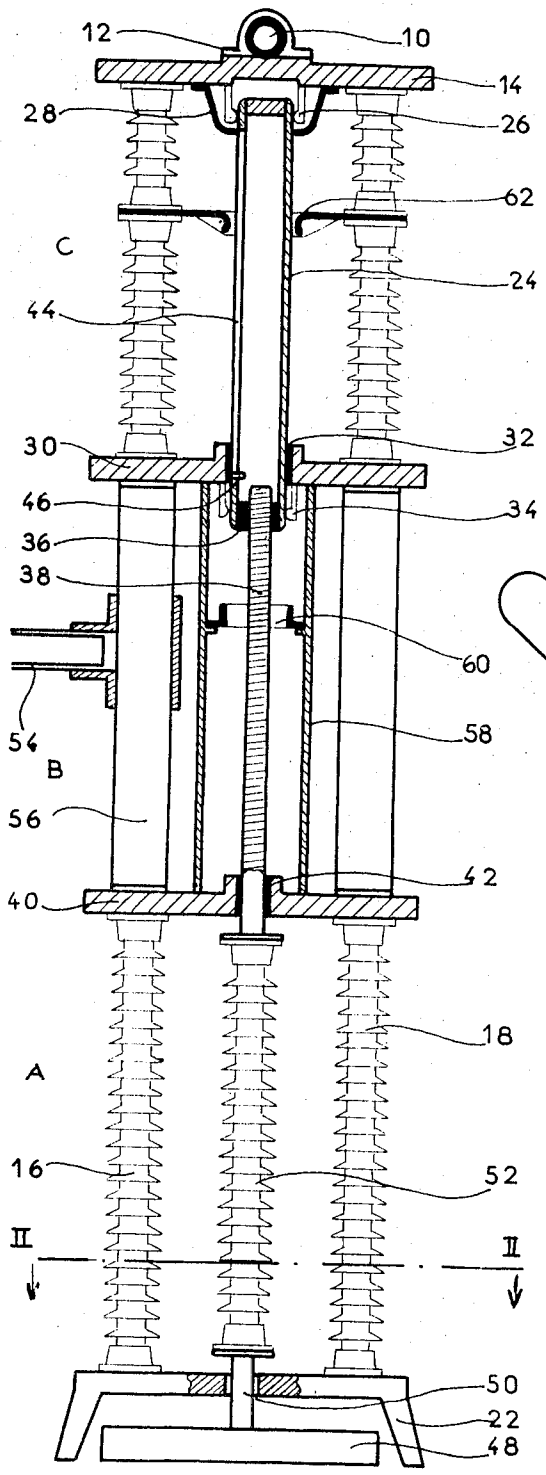

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FIG.1

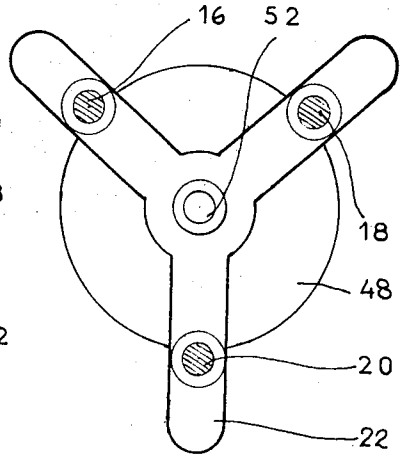
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FIG.2

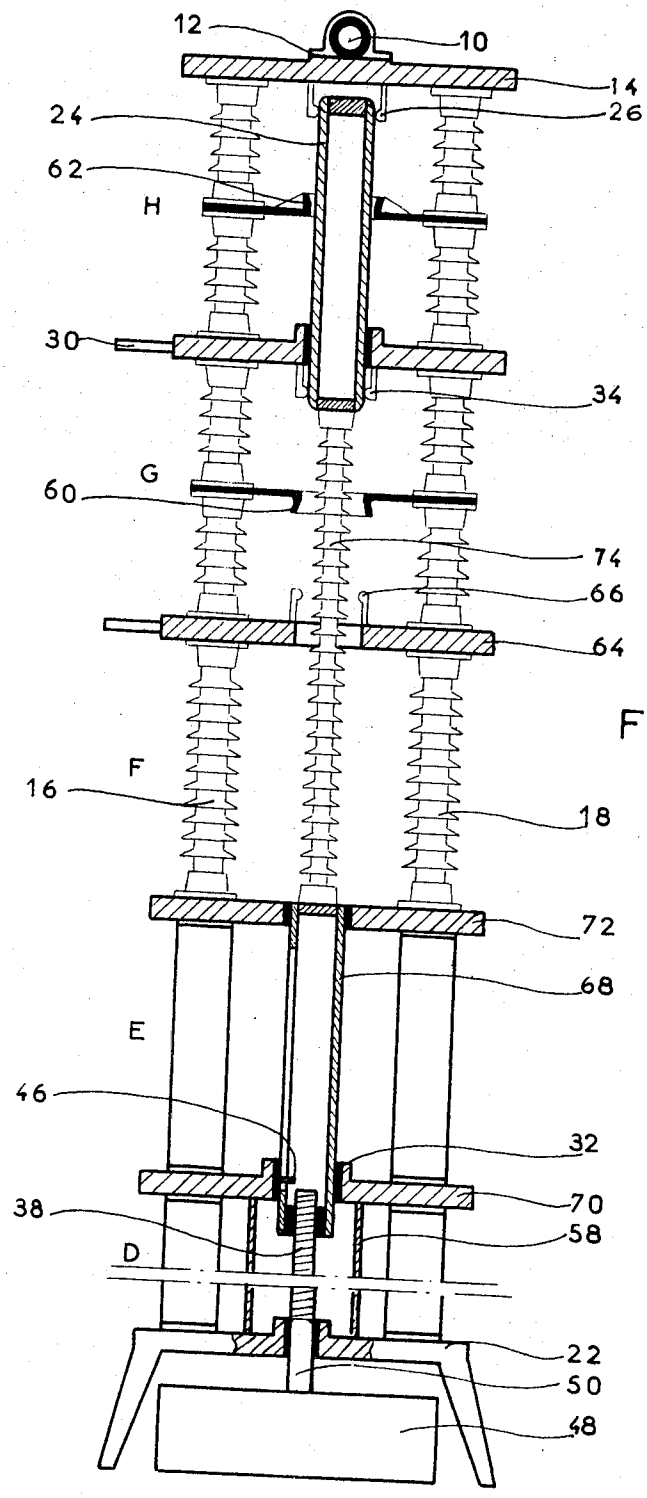
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FIG.3

Fig. 4

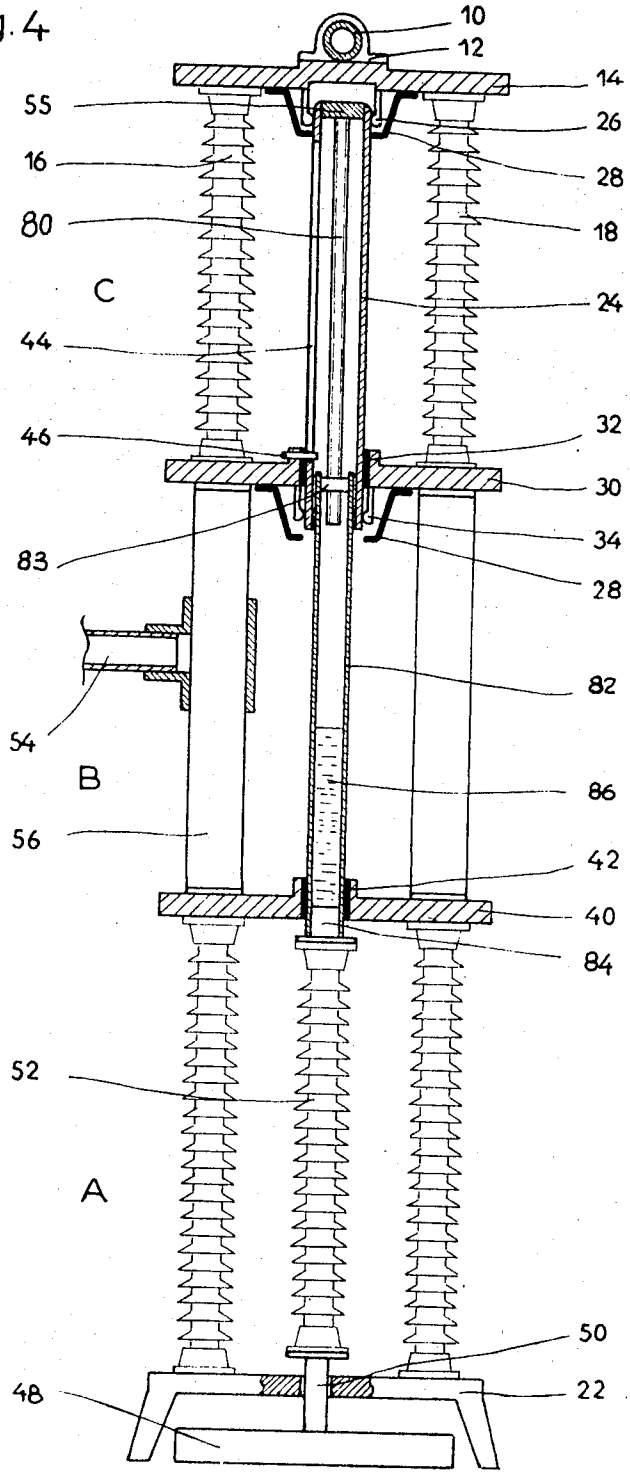
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Fig. 5

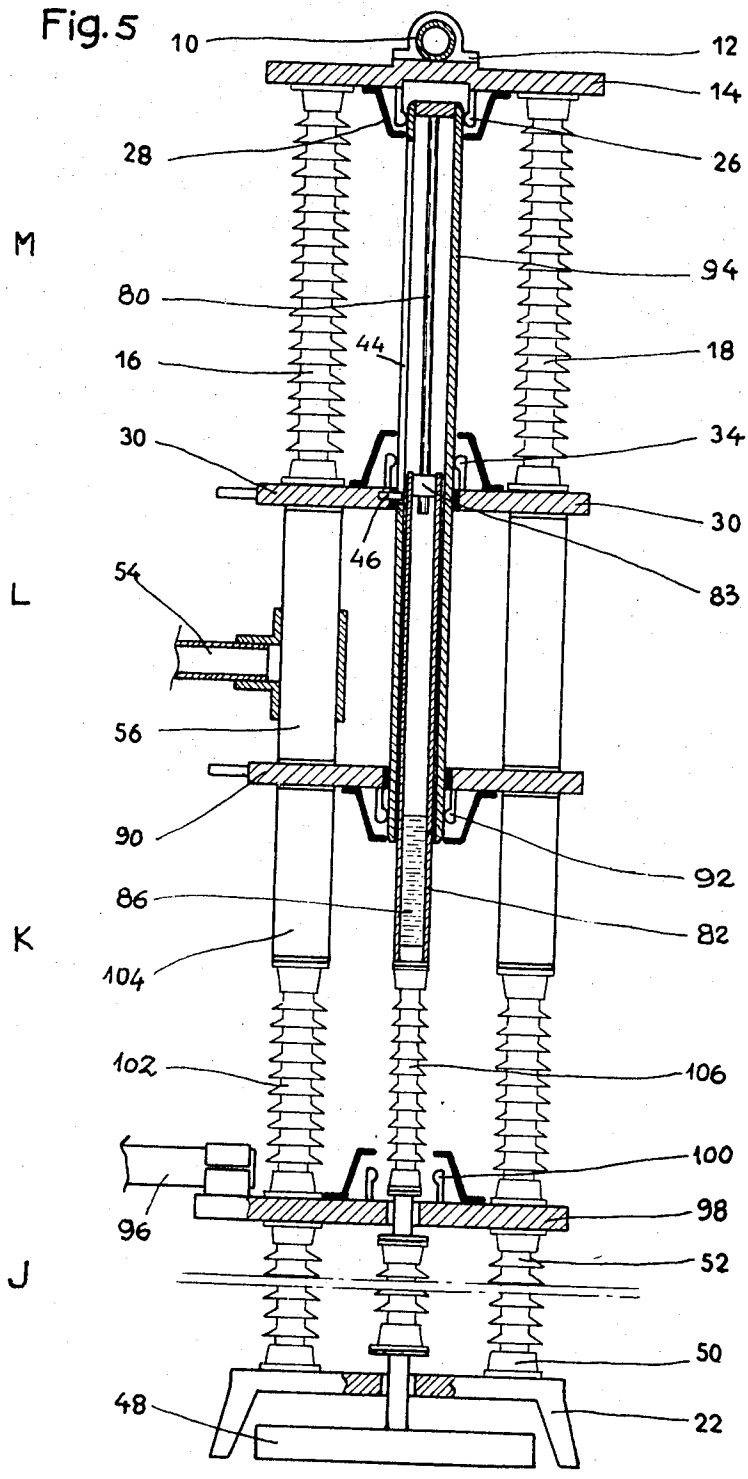
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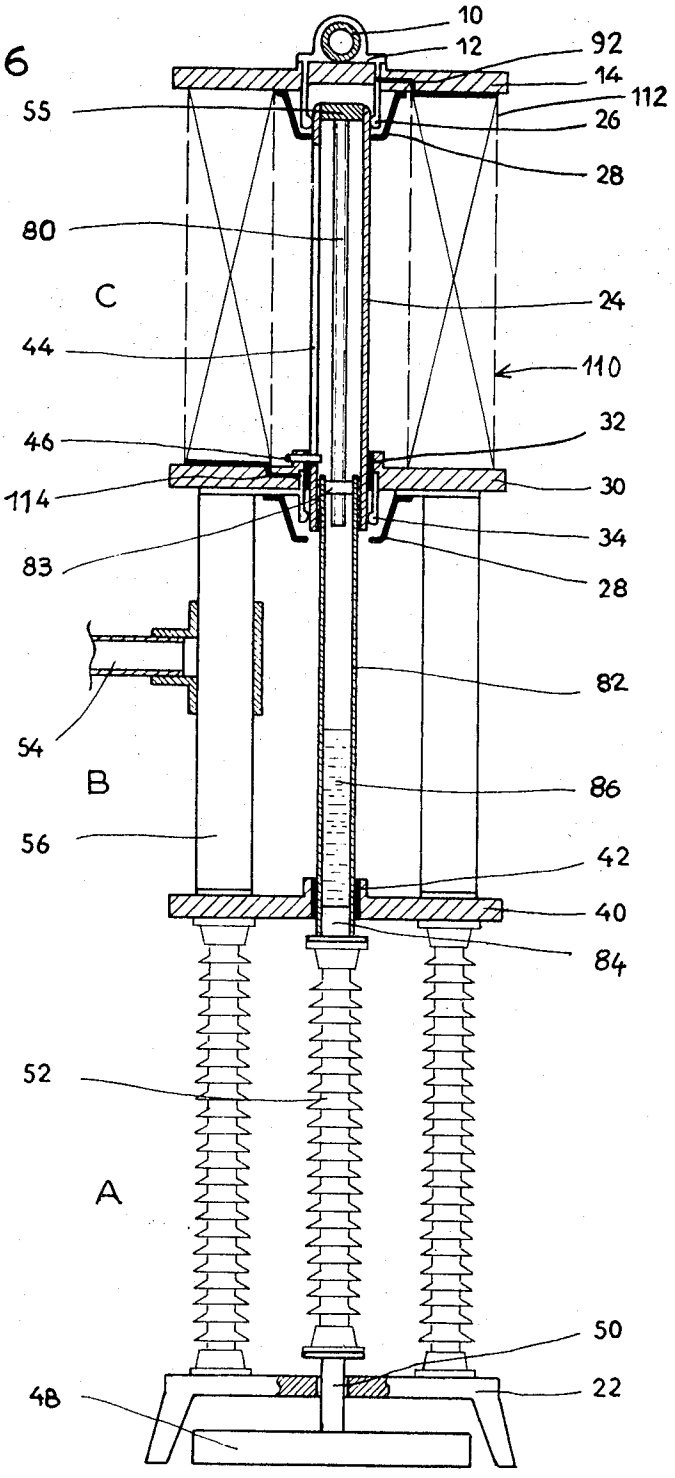
Fig. 6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HIGH-VOLTAGE DISCONNECTING SWITCH WITH SLIDING CONTACT

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a high-voltage disconnecting switch for establishing an electrical connection between two vertically spaced fixed contacts by means of a moving contact which can be moved in vertical translation by a threaded-rod drive mechanism cooperating with an internally threaded element.

2. Description of Prior Art

There are known outdoor disconnecting switches of this type in which the moving contact is formed of a telescopic contact supported by an insulating column and the upper end of which, in the closed position of the apparatus, engages a moving contact suspended from an electric high-voltage line.

These disconnecting switches are not suitable in installations such as electric apparatus test installations which employ a very high current when the disconnecting interval, the length of which depends essentially on the value of the voltage employed, is high, since the guiding of the moving contact over a long distance of travel becomes a problem.

SUMMARY OF INVENTION

The object of the invention is to overcome this drawback and to provide a disconnecting switch whose moving contact is capable of passing over a substantial distance with complete safety and of carrying a high current.

Another object of the invention is to provide a disconnecting switch the technical construction of which permits a practically unlimited extension adaptable to a wide range of voltages and currents.

Another object of the invention is to provide a disconnecting switch of the type mentioned which makes it possible to obtain a particularly compact and strong construction of the electrical installation in which it is incorporated.

The disconnecting switch in accordance with the invention is characterized by the fact that its fixed contacts and moving contact as well as its control rod are arranged in the axis of a supporting structure which comprises a plurality of superimposed sections delimited by transverse plates. The plates of the upper section support the fixed contacts and comprise guide means for the moving contact.

In accordance with one development of the invention, the upper plate of the upper section directly supports the high-voltage conductor to which one of the fixed contacts is connected.

In accordance with another development of the invention, one of the plates of one of the sections of the apparatus supports a third fixed contact cooperating with the moving contact so as to permit the apparatus to establish selective switching.

In an installation provided with a choke coil, the latter may advantageously be incorporated, in accordance with the invention, coaxially in one of the sections of the switch and in particular be fastened to the transverse plates of the upper section.

Preferably the plates of the different sections are supported by vertical columns which are insulating or conductive, depending on the function of the sections, and are arranged at the apices of a regular polygon such as an equilateral triangle.

In a preferred embodiment of the invention, the moving contact is tubular and the different sections have a length substantially equal to that of the moving contact. A threaded rod may be integral with the tubular contact and arranged axially within it to cooperate with a nut rigidly connected with a rotary tube controlling the movement of the moving contact which can receive the rod and cooperate telescopically with the moving contact during its opening movement. The control tube can be filled with a lubricant which bathes one end of the threaded rod in the open position of the moving contact.

Finally, in accordance with the invention, one can provide an electrical connection of variable height to one of the fixed contacts by means of a sliding current socket which surrounds a cylindrical conductive column of one of the sections of the supporting structure.

BRIEF DESCRIPTION OF THE DRAWING

Other advantages and characteristics of the invention will become evident from the following description of various embodiments of the invention given by way of illustration and not of limitation and shown in the accompanying drawings in which:

FIG. 1 shows in elevation and in axial section a supporting device of a disconnecting-switch conductor incorporated in accordance with the invention;

FIG. 2 is a horizontal section along the line II—II of FIG. 1;

FIG. 3 shows a changeover-disconnecting switch in accordance with the invention shown in elevation and in axial section;

FIG. 4 shows a variant of the switch shown in FIG. 1;

FIG. 5 is a view still in elevation and in axial section of another embodiment of a changeover-disconnecting switch, and

FIG. 6 shows a disconnecting switch with choke coil.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Identical or similar parts have been designated with the same reference numbers in the different figures.

In FIGS. 1 and 2, a conductor **10** such as an electric bar or a line of high or very high voltage is flanged at **12** on an upper plate **14** of a supporting structure formed, in the example shown in the drawing, of three insulating columns **16, 18, 20** arranged at the apices of an equilateral triangle and resting at their bottom on a base **22** provided on the ground. The number of supporting columns may, of course, be different and the conductor **10** may be a simple connecting terminal. At the center of the supporting structure there is incorporated a connecting or disconnecting device consisting of a conductive tube **24** mounted for vertical sliding which, in the upper closed position, cooperates with a contact clamp **26** having elastic fingers which are elastically urged against the outer wall of the tube **24** and are fastened to the lower face of the upper plate **14**. A protective screen **28** fastened to the plate **14** confines a space in which the contact clamp **26** is arranged and protected. The lower part of the tube **24** slides in an orifice provided in a lower plate **30** and jacketed by an anti-friction ring **32** while cooperating with a contact clamp **34** of the same construction as the clamp **26** and applied to the lower face of the plate **30**. The lower end of the tube **24** bears an internal thread, at least in its lower portion, which, in the example illustrated in the drawing, consists of an internally threaded element or nut **36** inserted in the base of the tube **24** and secured to the latter by any known means. An externally threaded rod **38** is screwed into the nut **36** and is rotatably mounted at its base in a supporting plate **40** through which it passes via an anti-friction sleeve **42**. The length of the threaded rod **38** corresponds substantially to that of the contact tube **24** so that by a screwing movement of the rod **38** in the nut **36**, the assembly consisting of the tube **24** and the threaded rod **38** is retracted, the threaded rod coming into the inside of the tube **24**. The contact tube **24** has a longitudinal groove **44** in which there engages a positioning spur **46** borne by the plate **30** which immobilizes the tube **24** for rotation while permitting longitudinal sliding caused by the rotation of the threaded rod **38** which is locked against translation. A mechanical drive **48**, such as an electric motor or any other operative system, is fastened to the base of the structure or frame **22**, the rotary drive shaft **50** being rigidly attached to the threaded rod **38** by an insulating part such as a core insulator **52**.

The plates **40** and **30** are interposed in insulating supports **16, 18, 20** at the level of the assemblies of the component elements of the different columns by subdividing the support

structure into three sections A, B and C extending between the frame 22 and the plate 40, between the plate 40 and the plate 30, and between the plate 30 and the upper plate 14, respectively. The heights or lengths of these three sections A, B, C are substantially equal and correspond to the insulation distance for the voltages used. The threaded rod 38 of conductive material extends over the entire height of the intermediate section B which therefore cannot participate in the insulation. A current socket 54 connected to the lower clamp 34 can therefore be arranged at any place on this section without affecting the insulation, and in the example shown in FIG. 1, the socket 54 is slidably mounted on a tube 56 which forms part of the supporting structure. The terminal 54 is advantageously connected electrically to the clamp 34 by the conductive tube 56 and the plate 30 which is also of conductive material. By symmetry the other insulating columns of the supporting structure in the section B are also replaced by tubes similar to tube 56.

Between the plates 30 and 40 and coaxially to the threaded rod 38 there is inserted a protective tube 58 which surrounds the rod 38. A guide 60 is borne by the inner face of the tube 58 and is arranged to cooperate with the tubular contact 24 during the retraction movement. In the support section C there is provided a guide 62 similar to the guide 60 and arranged in such a manner that in any position of the tubular contact 24, the latter is guided at least by one of the guides 60 or 62. One can of course provide additional guides staggered along the path of the contact tube 24.

The disconnecting switch of FIG. 1 operates in the following manner:

In closed position, shown in FIG. 1, the conductor 10 is connected electrically to the socket 54 via the clamp 26, between the fingers of which there is inserted the end of the tubular contact 24, the tube 24, the clamp 34, the lower plate 30 and the tube 56. The moving contact zones are reduced to the clamps 26 and 34 which are adapted to withstand the high currents used.

The opening of the switch is effected when the conductor 10 is not under voltage by the placing in operation of the motor 48 which rotates in proper direction the threaded rod 38 via the insulating connecting rod 52. The nut 36 screws itself on the rod 38 and in its sliding movement drives the tubular contact 24 downward, it being guided by the guides 60 and 62 and the sleeve 32 of the plate 30. The spur 46 prevents any rotation of the tube 24. In open position, the tube 24 is flush with the lower plate 30 and is entirely withdrawn from section C of the supporting structure which assures insulation between the contact members of the switch. The length of section C is of course adapted to the electric voltage. The contact tube 24 surrounds the threaded rod 38 and the height of the conductive portion inserted in the structure is therefore limited to the section B. The threaded rod 38 and the tube 24 constitute a telescopic unit which can be extended and retracted, and is driven by the rotation of the threaded rod 38.

The threaded-rod drive is particularly strong and provides substantial operating forces. The irreversible nature of this mechanism assures automatic locking in any position and the operating stroke can be substantial without substantially increasing the space taken up.

Section B of the structure does not participate in the insulation which is assured with respect to ground by section A and with respect to the conductor 10 by section C. The current socket 54 is positioned at a height adapted to the height of the terminal (not shown) of the apparatus to be connected and this height is adjustable by simply sliding current socket 54 on the column 56, which avoids connections by braiding or articulated rods.

The disconnection is visible and the mechanical parts, particularly the contact clamps 26 and 34 and the threaded rod 38, are protected from the weather by the screens 28, 58 and the plates 14, 30.

The closing of the switch is effected obviously by rotation of the threaded rod 38 in the opposite direction. It should be noted that the space taken up by the structure of the support of the conductor 10 is scarcely increased by the incorporation of the disconnecting device and that the apparatus can be adapted to any voltages by using constituent parts of the same shape but suitable size.

FIG. 3 shows a variant embodiment of the invention in which the switch is arranged as a reversing switch. The supporting structure of the conductor 10 is subdivided into five sections D, E, F, G and H. The upper section H, defined by the plates 14 and 30, is identical to section C of FIG. 1 and therefore need not be described. Section G extends below section H between the plate 30 and a plate 64 which are connected by insulating columns 16, 18, 20. With the lower plate 64 there is associated a contact clamp 66 which can cooperate with the tubular contact 24 in lowered position, which contact in this case connects the clamps 34 and 66. The section F corresponds to section A of FIG. 1 and assures insulation with respect to the ground.

The operating device comprises an extendable threaded rod element 38 cooperating by threading with a tubular spacer 68 and driven in a manner identical to that shown in FIG. 1, for instance by a motor 48. The threaded rod 38 extends over a height of the supporting structure corresponding to the section D, defined at the base by the frame 22 and at the top by a supporting plate 70 traversed at its center by the spacer 68 which is guided therein by the sleeve 32 and the spur 46. In extended position, the spacer tube 68 extends between the plates 70 and 72 over section E of the structure. The tubular contact 24 and the spacer tube 68 are rigidly connected by an insulating connecting rod 74.

The operation of the reversing switch of FIG. 3 can be noted from the previous description, and it is sufficient to point out that in the position illustrated in the figure, which corresponds to the extension of the threaded rod 38-tube 68 telescopic system, the tubular contact 24 connects the clamp 34 to the conductor 10, and in the retracted position, the tubular contact 24, in lowered position, connects the clamps 34 and 66. The drive device is at ground potential and it is therefore needless to employ insulating supports at the lower part of the structure on sections D and E. It can easily be seen that the properties of strength and reliability in use are retained in full, only the height of the apparatus being changed.

The switch shown in FIG. 4 is a variant of that shown in FIG. 1, but the drive mechanism for the tubular contact 24 is slightly different.

The threaded rod 80 is maintained rigidly connected to the contact 24 by the spacer 55 and is arranged axially within contact 24. A drive tube 82 extends over the entire height of section B and is rigidly connected with the drive insulator 52 which supports it. This tube 82 bears at its upper end a nut or internally threaded ring 83 screwed onto the threaded rod 80. The outside diameter of the drive tube 82 is slightly less than the inside diameter of the moving contact 24 so that the tubes 24 and 82 constitute a telescopic assembly which assures an excellent guiding of the contact 24 by the tube 82. A plug 84 closes the bottom of the tube 82 tightly making it possible to fill the tube with a lubricant 86 which bathes the end of the threaded rod 80 when the latter is housed in the tube 84 in the open position of the switch. It is noted therefore that the operating mechanism constitutes a closed assembly which is protected from the elements and has a self-lubricating means.

It will now be understood that it is sufficient to drive the insulator 52 in rotation in order to cause the rotation of the tube 82 and of the nut 83 on the one hand and the vertical translation of the moving contact 24 on the other hand due to the threaded rod 80 which cannot rotate because of the spur 46 which engages in the slideway 44 of the contact 24. In its open position, the tube 24 is substantially entirely within section B and surrounds the drive tube 82, while the threaded rod 80 is housed within this tube 82.

FIG. 5 illustrates a variant embodiment of the invention in which the switch is arranged as a reversing switch. The supporting structure of the conductor 10 is subdivided into four

sections J, K, L and M. The upper section M, defined by the plates 14 and 30, is identical to section C of FIG. 4 and therefore need not be described. Section L extends below section M between the plate 30 and a plate 90, which plates are connected by cylindrical conductive columns 56. With the lower plate 90 there is associated a contact clamp 92 which can cooperate with the tubular contact 94 the length of which is greater than the height of section M and the operating stroke. Whatever the position of the contact tube 94, the clamps 34 and 92 are in permanent contact with it and can be used as desired for the current socket at different levels. A terminal 54 of adjustable height can be slidably mounted on the conductive column 56 in the manner described above. The section L does not participate in the isolating of the supporting structure and its height is advantageously less than that of section M.

The lower opposite terminal 96 of the reversing device is borne by a plate 98 interposed in the supporting structure and it is connected to a contact clamp 100 capable of receiving the lower end of the contact tube 94 in the lowered position of the latter, in which position it electrically connects the clamps 34 and 92 to the clamp 100. Section K of the supporting structure, defined by the plates 90 and 98, is of a height close to that of section M and it assures isolation between the clamp 92 and the lower outlet clamp 100 of the reversing device. As the insulation requirements imposed in this zone are less than those in the vicinity of the bar 10, the columns of the supporting structure need not necessarily be of insulating material over the entire height of section K and may comprise an insulating base 102 over which there is a conductive portion 104. In accordance with the invention, this feature is utilized in order to limit to the maximum the height of the structure in the manner which will be described below.

Section J of the supporting structure of FIG. 5 is identical to section A of FIG. 1 and it assures insulation with respect to the ground.

The operating mechanism consists on the one hand of the screw or threaded rod 80 which is coaxial to and within the tubular contact 94 but of lesser length and on the other hand of the nut 83 fastened to the end of the tubular member 82 whose length is equal to that of the rod 80 which, in retracted position, is completely housed therein. The tubular member 82 is borne by an insulating rod 106 of the same outside diameter and capable of being surrounded by the tubular contact 94 in lowered position of the latter. A supply of lubricant 82 is provided in the tubular member 82.

The operation of the reversing switch of FIG. 5 is clear from what has been previously stated, and it is sufficient to point out that in upper position, illustrated in FIG. 5 and corresponding to the extension of the telescopic system consisting of the tubular member 82 and the tubular contact 94, the latter connects the clamp 26 associated with the conductor 10 to the clamps 34 and 92, while in the retracted position, the clamps 34 and 92 are connected by the lower tubular contact 94 to the clamp 100. It is easy to see that the height of the support of FIG. 5 is only slightly increased as compared with that of FIG. 1 by an amount corresponding to section L which is of a height less than the stroke of the tubular contact 94.

In FIG. 6, a choke coil 110 is interposed between the plates 30 and 14 of the supporting device, assuring the mechanical continuity of the supporting structure of the conductor 10. The upper end 112 of the coil is electrically connected to the conductor 10 and to the contact clamp 26 which is capable of receiving the upper end of the conductive contact tube 24 coaxial with the coil 110 and capable of sliding under the action of a screw and nut drive system 83, 80. The lower end 114 of the coil is connected to the contact clamp 34 of the connector and to the current socket 54. The plates 14 and 30 are advantageously made of insulating material in order to avoid any induced current.

The operation of the device of the invention is obvious:

In the closed position of the switch, shown in FIG. 6, the sliding tube 24 is engaged in the clamps 26 and 34 and it short-circuits the choke coil 110 directly connecting the current socket 54 with the conductor 10. The insertion of the coil is effected by retraction of the sliding contact 24 produced by rotation of the tubular member 82 and of the nut 83 in the manner described above. The tube 24 then surrounds the member 82 and is totally withdrawn from the section defined by the plates 30 and 14 which contain the coil, which is inserted in the circuit between the conductor 10 and the current socket 54.

The invention of course is by no means limited to the embodiments which have been more particularly described and shown by way of example in the accompanying drawings, but rather it extends to any variant falling within the scope of electrical or mechanical equivalents. It is, for instance, possible to have the switch fulfill the function of a grounding switch, which will make it possible in the embodiments shown in FIGS. 1 and 4 to eliminate section A.

What is claimed is:

1. A high voltage switch, comprising: a supporting structure having a plurality of superimposed sections defined by spaced apart transverse plates; a plurality of axially aligned members disposed between at least first and second of said transverse plates to maintain them in spaced apart relationship; first and second axially spaced apart fixed contact means connected to said first and second transverse plates, respectively; a movable contact member extending axially of said supporting structure and movable between a first position in contact with said first and second fixed contact means and a second position out of contact with at least one of said first and second fixed contact means; drive means, including a threaded drive rod extending axially of said switch; a threaded member connected to said movable contact member and engaging said drive rod; and means to rotate said drive rod about its longitudinal axis, wherein said movable contact is moved axially along the longitudinal axis of said drive rod between said first and second positions.

2. A high voltage switch according to claim 1, wherein said axially aligned members disposed between said first and second transverse plates comprise circumferentially spaced apart insulating columns.

3. A high voltage switch according to claim 2, further comprising: a third transverse plate spaced apart from said first and second transverse plates; a plurality of second axially aligned insulating members disposed between said second and third transverse plates to maintain them in spaced apart relation; and third fixed contact means connected to said third transverse plate; wherein, in said first position said movable contact member electrically connects only said first and second fixed contact means to each other and in said second position electrically connects only said second and third fixed contact means to each other.

4. A high voltage switch according to claim 2, further comprising: a third transverse plate spaced apart from said first and second transverse plates; a plurality of axially aligned members disposed between said second and third transverse plates to maintain them in spaced apart relation, at least one of said axially aligned members being made of electrically conductive material; and means electrically connecting said second fixed contact means to said conductive axially aligned member.

5. A high voltage switch according to claim 4, means connected to said first axially aligned members and means connected to said second transverse plates for guiding said movable contact member axially between said first and second positions.

6. A high voltage switch according to claim 4, further comprising: a fourth transverse plate spaced apart from said third transverse plate; a plurality of third axially aligned insulating members disposed between said third and fourth transverse plates to maintain them in spaced apart relation; and third and fourth fixed contact means connected to said third and fourth transverse plates, respectively; wherein, in said first position, said movable contact member electrically connects only said first, second and third fixed contact means to each other and

in said second position electrically connects only said second, third and fourth fixed contact means to each other.

7. A high voltage switch according to claim 4, further comprising an adjustable terminal slidably mounted on said at least one axially aligned conductive member.

8. A high voltage switch according to claim 1, wherein said axially aligned members disposed between said first and second transverse plates comprise at least one electrical choke coil connected to said first and second fixed contact means.

9. A switch according to claim 1, wherein said drive rod comprises a tubular vessel containing a lubricant and said movable contact member comprises a threaded inner rod disposed in threaded engagement with said drive rod and adapted for at least partial contact with said lubricant in its said lower position.

10. A switch according to claim 1, said movable contact member comprising a cylindrical contact having a length substantially corresponding to the distance separating said first and second fixed contact means.

11. The switch according to claim 1, wherein said movable contact means is tubular and rigidly connected with said threaded rod, said rod being arranged axially within said movable contact means to cooperate with said internally threaded element, said threaded element being rigidly connected with a rotary drive tube arranged to be telescopically surrounded by said movable contact means in the open position of said switch.

12. The switch according to claim 11, wherein said drive tube contains a supply of lubricant to bathe one end of said threaded rod when the switch is in the open position.

13. The switch according to claim 11 wherein the length of said movable contact means is substantially greater than the length of its stroke and wherein said movable contact means cooperates with four fixed contacts staggered along said support structure.

14. The switch according to claim 1 wherein said first transverse plate supports a high voltage conductor to which one of said fixed contacts is connected.

15. An elongated high-voltage disconnecting switch structure comprising an upper and a lower generally horizontally extending assembling plate, said lower assembling plate having a central opening, first circumferentially disposed and vertically extending support means supporting said upper assembling plate from said lower assembling plate, second circumferentially disposed and vertically extending support means to support said lower assembling plate from the ground, an upper and a vertically aligned lower stationary contact secured to the central portion of said assembling plates, respectively, a generally cylindrical movable contact member extending axially of said structure and reciprocally movable longitudinally through said opening between an upper closed-circuit position wherein said movable contact member engages said upper and said lower stationary contact and a lower open-circuit position wherein said movable contact member is substantially withdrawn from the space separating said stationary contacts, a rotatably actuating rod member extending in line with said movable contact member between said lower assembling plate and the ground, said actuating rod member and said movable contact member being in threaded engagement one with the other in the vicinity of said lower assembling plate to operate the reciprocating movement of said movable contact member upon rotation of said actuating rod member.

16. The switch according to claim 15, further comprising a third horizontally extending assembling plate and a third stationary contact secured to the central portion thereof, said third assembling plate being disposed below said lower assembling plate at a distance substantially equal to the distance separating said upper and lower assembling plates, a plurality of circumferentially disposed insulating columns supporting said lower assembling plate from said third assembling plate wherein said movable contact member in said lower position engages said lower and said third stationary contact.

17. The switch according to claim 15, further comprising a third and a fourth horizontally extending assembling plate and a third and a fourth stationary contact secured to the central portion thereof, said higher, said lower, said third and said fourth assembling plates being vertically spaced apart in a manner such that such movable contact member is selectively engageable with said higher and lower stationary contacts and said third and fourth stationary contacts.

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