(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 011 972
B2

(12) **NEW EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of the new patent specification: 23.08.89

(51) Int. Cl.⁴: H 01 H 33/18, H 02 B 13/00

(21) Application number: 79302617.0

(22) Date of filling: 19.11.79

(54) **Electrical switchgear.**

(30) Priority: 28.11.78 GB 4635778
25.05.79 GB 7918466

(43) Date of publication of application:
11.06.80 Bulletin 80/12

(45) Publication of the grant of the patent:
18.01.84 Bulletin 84/3

(45) Mention of the opposition decision:
23.08.89 Bulletin 89/34

(84) Designated Contracting States:
AT BE CH DE FR IT LU NL SE

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EP-A-0 021 577
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EP 0 011 972 B2

LIBER, STOCKHOLM 1989

Description

This invention relates to electrical switchgear, the term "switchgear" being used to embrace circuit breakers and other electrical switches.

A common form of distribution switchgear for voltages up to 36 kilovolts incorporates circuit breakers of the oil-filled type isolated from fixed units by vertical withdrawal. This range of switchgear also incorporates non-automatic load break switches and, especially for voltages of 12 kilovolts and lower, ring main equipment incorporating at least three switch functions to control, for example, a transformer and two ring main cables.

Although this type of equipment has been used satisfactorily for many years, in recent times circuit breakers have been developed which make use of the highly insulating gas sulphur hexafluoride to extinguish an arc drawn between contacts and subsequently made to rotate. It would be desirable to apply rotating arc sulphur hexafluoride techniques to the above-described switchgear to gain the advantages of higher interrupting performance with a corresponding reduction in the frequency of contact maintenance and freedom from fire hazard. It is particularly desirable for this class of equipment because of the small mechanical energy requirements resulting from the relatively short contact stroke and the fact that a mechanical compression device or puffer is not required. However, difficulties are experienced in applying rotating-arc sulphur hexafluoride techniques to circuit breakers and switches of the size associated with distribution switchgear up to 36 kilovolts. These difficulties include the need to ensure that the arc can be made to rotate reliably at all values of breaking current, and the need to provide a compact and economical arrangement which is not at a disadvantage in size or requirements of mechanical operating energy with respect to oil-filled equipment.

A switchgear construction which is capable in principle of satisfying the above-described needs is described in the paper CONTACTS ELECTRIQUES, Paris 17 - 21 June 1974, pages 266 - 272, reference R1668-41. In this construction, during opening of the switchgear contacts an arc is formed between a first contact in the form of a contact arm and a tubular arcing electrode, the arcing current flowing through a field coil connected electrically in series with the arcing electrode to produce a magnetic field which causes the arc to rotate with one root thereof maintained on the first contact and to become extinguished. In the contacts closed position of the switchgear, the first contact is engaged by a second contact disposed externally of the field coil, the second contact being pivotable about an axis transverse to the axis of the field coil and having an end portion which moves transversely of the field coil axis. In this way, an initial arc is drawn across a pole face of the field coil between the first and second contacts during movement of the contacts to their open position, and during further movement of the contacts towards said open position the arc is caused to transfer its other root from the second contact to the tubular arcing electrode by the action of the end portion of the second contact passing within a short distance from the arcing electrode.

This particular switchgear does however suffer from the disadvantage that, because the end portion of the second contact moves away from the field coil axis as the contacts are opened, transfer of the arc root to the arcing electrode does not take place until relatively late in the contact stroke. Prior to such transfer, the arc is in a relatively unstable state and due to its immobility will cause erosion of the contacts. In addition, after the root has transferred from the second contact to the arcing electrode, the arc adopts as planar, spiral configuration and migrates to a position where the magnetic field strength is greatest, i.e. at the axial mid-plane of the field coil. This arrangement is not particularly conducive to lengthening of the arc to facilitate extinction, nor for removal of the arcing products from within the arcing electrode. These factors combined serve to impose a limitation on the current interrupting capability of the switchgear.

In US Patent No. 3 156 803 there is disclosed a switchgear construction in which a second contact is positioned relatively close to the arcing electrode. Although this general principle can be utilised to overcome the first of the above-mentioned limitations, it still does not achieve optimum lengthening of the rotating arc, nor are the arcing products effectively conducted away from the arcing region.

It is an object of the present invention to obviate or mitigate this particular limitation. According to one aspect, the invention achieves this object by arranging for the second contact to be positioned adjacent to the tubular arcing electrode, for the first contact to be elongate and to be pivoted at a point remote from its said end portion at a point on the field coil axis external to the field coil so as to be pivotable about an axis transverse to the field coil axis, for the end portion of the first contact to move towards the field coil axis as the contacts are opened, and for the end portion to lie along the field coil axis with the end portion remote from the pivot being disposed at a pole face of the field coil when the contacts are in their fully open position.

According to a second aspect of the invention, the second contact is positioned adjacent to the tubular arcing electrode, the first contact is cranked and is pivoted at an end thereof remote from its said end portion at a point external to the field coil and spaced from the field coil axis, the end portion of the first contact moves towards the field coil axis as the contacts move towards said open position, and the end portion lies along the field coil axis with the end of the end portion remote from the pivot extending into the field coil when the switchgear is fully open.

Attention is hereby drawn to the fact that the embodiments of figs. 6, 7, and 10 are also disclosed in our European Application EP-A-0 012 522, published 25.06.1980, claiming a priority date of 28.11.1978, which claims electrical switchgear employing an electrically insulating fluid for arc extinction and comprising a pair of switches each having first and second contact means which are relatively mowable between a closed position in which they are mutually engaged and an open position in which they are mutually separated, and an arcing electrode arrangement and shared field coil for both switches, movement of each switch to its open position causing an arc to be produced between the first contact means and the arcing electrode arrangement such that the arcing current flows through the shared field coil to create an arc-rotating magnetic field to extinguish the arc, characterised in that the second contact means of both switches are electrically connected to a common point, the shared field coil is electrically connected between said common point and the arcing electrode arrangement, and interlock means is provided to prevent simultaneous opening of the two switches.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a first embodiment of electrical switchgear according to the present invention, in the form of a circuit breaker for a single-phase electrical supply or one phase of a circuit breaker for a three-phase supply;

Figure 2 is a view in the direction of arrow II in Figure 1 of part of the electrical switchgear shown therein;

Figure 3 is a side view, partly in section, of a second embodiment of electrical switchgear according to the present invention;

Figure 4 is a front view, partly in section, of the electrical switchgear shown in Figure 3;

Figure 5 is schematic plan view of the electrical switchgear shown in Figures 3 and 4;

Figure 6 is a schematic diagram of a third embodiment of electrical switchgear according to the present invention, for use with ring main equipment;

Figure 7 shows a number of modifications which can also be applied to any of the above embodiments;

Figure 8 shows a further modification which can also be applied to any of the above embodiments;

Figure 9 is a sectional view taken along the line IX-IX in Figure 8; and

Figure 10 is a schematic diagram of a fourth embodiment of electrical switchgear according to the present invention, also for use with ring main equipment.

Referring to Figure 1, a circuit breaker is shown suitable for replacing an existing 12 or 36 kilovolt oil-filled circuit breaker in an electrical distribution system. The circuit breaker comprises a switch 1 contained in a gas-tight metal housing 2 on which terminal bushings 3 and 4 are mounted. The housing 2 and terminal bushings 3 and 4 correspond respectively to the tank and bushings of a conventional oil-filled circuit breaker. The interior of the housing 2 does not, however, contain oil but the well-known, highly insulating gas sulphur hexafluoride for the purpose of arc quenching. The gas is present preferably at a pressure of 3.17 kg/cm^2 (45 psi), and is supplied through a valve (not shown) in a wall of the housing 2. The mechanism of the circuit breaker is so constructed and arranged as to enable sulphur hexafluoride arc quenching to be applied to the breaking of currents occurring in an electrical distribution system within the space limitation imposed by making the circuit breaker a replacement for an existing oil-filled circuit breaker.

A conductor 5 passes through the bushing 3 and carries on its end within the housing 2 a transverse contact support arm 6 which carries resilient contact fingers 7, and a support member 8 which carries a field coil 9. A conductor 10 passes through the bushing 4 and carries on its end within the housing 2 a mounting 11 on which a mowable contact arm 12 of circular cross-section is mounted for angular movement about a pivot 13. A flexible, electrically conductive strap 14 connects the contact arm 12 to the conductor 10 for the passage of most of the load current therethrough, the strap 14 being connected to the conductor 10 by way of an L-shaped copper bracket 15 and being bolted to the contact arm 12. As an alternative to the provision of the strap 14, the contact arm 12 can be mounted on the end of the conductor 10 by means of a spring loaded pivot through which the load current passes in use.

An operating shaft 16 is rotatable by means of an operating mechanism (not shown) disposed externally of the housing 2 and carries an arm 17 which is pivotally connected to one end of a linkage comprising a pair of parallel, spaced links 18 (only one shown) made of insulating material, such as PERMALI (Registered Trade Mark) which is a densified resin beech. The other end of the linkage is pivotally connected to the contact arm 12 at or near the centre of the latter, such that rotation of the shaft 16 causes the contact arm 12 to move angularly about the pivot 13 between a position in which an end portion 19 thereof is engaged with the contact fingers 7 (as shown in chain-dotted lines) and a position in which the end portion 19 is disengaged from the fingers 7 and is disposed on the axis of the field coil 9 (as shown in full lines). In the latter position of the contact arm 12 the axis of the operating shaft 16, the pivotal connection between the arm 17 and the linkage 18 and the pivotal connection between the linkage 18 and the contact arm 12 are substantially in a common plane. Therefore, any slight movement of the arm 17 due, for example, to play between the various parts or oscillation of the parts due to the absorbing of shocks upon opening of the switch will result in only a very small movement of the contact arm 12, and thus the end portion 19 thereof will remain substantially on the axis of the field coil 9.

A plate 20 of arc-resistant material is provided adjacent the contact fingers 7 to protect the support member 8 and the field coil 9 from the effects of arcing. The arc-resistant material of which the plate 20 is made can be either conducting or insulating. If it is conducting, it must be ensured that the plate cannot short out the field coil 59. This can be arranged by fixing the plate 20 at an angle to the support member 8 so that it is normal to the end portion 19 of the contact arm 12 when the latter engages the contact fingers 7 and is directed away from the outer windings of the field coil and the support member 8. If necessary, for certain applications of the switchgear, the end portion 19 of the contact arm 12 can have a region 21 which is also protected by conducted arc-resistant material.

The support member 8 is made of mild steel such that it serves to concentrate the magnetic field produced by the field coil 9 and screens the coil from the effects of adjacent metalwork or current-carrying conductors. The support member comprises a portion 22 defining part of a cylinder (as shown to advantage in Figure 2) carried on integral mounting lugs 23. The field coil 9 comprises a spiral metal strip of the same width as the portion 22 and consists of, for example, twenty turns of sheet metal 0.5 mm thick. The turns are equally spaced from each other, insulation between the turns being provided by means of an insulating coating or an inter-wound insulating strip. An inner end of the field coil 9 is attached to and assists in supporting a tubular arcing electrode 24 made of non-ferrous metal which projects beyond the ends of the field coil and its support member. A suitable means of attaching the inner end of the field coil to the electrode is by rivetting and/or brazing or soldering. An outer end of the field coil is bolted between one of the lugs 23 and the support arm 6, as can be seen in Figure 2.

The above-described circuit breaker operates as follows. In a closed position thereof, the end portion 19 of the contact arm 12 is engaged with the contact fingers 7 so that current can flow through the circuit breaker by way of the conductor 10, the strap 14, contact arm 12, contact fingers 7 and the conductor 5. Opening of the circuit breaker is performed by rotating the operating shaft 16 by way of the aforementioned operating mechanism to pivot the contact arm 12 out of engagement with the contact fingers 7. During such movement of the contact arm 12, the end portion 19 thereof moves transversely relative to the end of the field coil 9 to draw an arc from the contact fingers 7 radially across the pole face of the coil. This arc subsequently transfers itself from the contact fingers 7 to the electrode 24, so that the field coil 9 (previously out of circuit) now forms part of the current flow path through the circuit breaker. The current flowing through the coil 9 creates a magnetic field which causes the arc to rotate in a known manner and become extinguished.

A porthole 25 is provided in side wall of the housing 2 so that a visual inspection can be made of the internal mechanisms. The porthole also permits photography of the rotating arcs to be taken.

The above arrangement can, if desired, be applied to a mere switch rather than to a circuit breaker.

The circuit breaker described above is intended to control one phase of a three phase electrical supply, similar circuit breakers being provided for the other two phases. The circuit breaker is, however, also suitable for controlling a single phase electrical supply.

The switchgear illustrated in Figures 3 to 5 is in the form of a circuit breaker for use with a three phase electrical supply, and comprises three switches 101a, 101b and 101c (one for each phase) contained in a common housing 102 filled with sulphur hexafluoride gas. Each of the switches is similar to that described above with reference to Figures 1 and 2, similar parts being denoted by the same reference numerals but with 100 added. A common operating shaft 116 is used to operate all three of the switches, and passes through a gas-tight bearing 126 in a side wall of the housing 102.

The three switches are disposed generally on a common axis 127. In order to optimise the electrical clearances and magnetic separations of the switches, the field coils 109 thereof are mutually staggered transversely of the axis 127. In the particular arrangement shown, this means that the coils 109 are disposed in a triangular array, as can be seen to advantage in Figure 5. The screening effect performed by the support members 108 is now of particular importance, since each support member shields its respective coil 109 from the effects of the other phases of the electrical supply.

Figure 6 illustrates switchgear for use with ring main equipment and comprises a pair of switches 201a and 201b for controlling respective ring main cables and a third switch 201c for a tee-off circuit. The switch 201c can provide automatic circuit breaking and/or can be associated with an externally-mounted high-capacity fuse: where three phases are provided, blowing of one such fuse can be arranged to cause the tee-off switches of all three phases to open.

Each of the switches 201a, 201b and 201c is generally similar to the switch 1 described above in relation to Figures 1 and 2, similar parts being accorded the same reference numerals but with 200 added. However, the link mechanism which connects the operating shaft 216 of each switch to the respective contact arm 212 differs slightly from the arrangement depicted in Figure 1, in that triangular plates 230 are provided on the contact arm and the linkage 218 is pivotally connected to these plates, rather than being connected directly to the contact arm.

The ring main switches 201a and 201b are disposed adjacent one another and share a common field coil 209, support member 208 and arcing electrode 224. The contact arms 212 of the two switches are disposed at opposite ends of the field coil 209, and an electrically insulating member 231 extends transversely across the centre of the electrode 224 to help isolate the contact arms from each other when the switches are both in their open positions. Because the field coil 209 is spirally wound, it is symmetrical about a transverse plane through its centre: the coil 209 can, therefore, be relied upon to provide the same operating characteristics for each of the two switches 201a and 201b. A mechanical interlock (not shown) of known type is provided to prevent simultaneous opening of the switches 201a and 201b although consecutive opening (after the arc in one circuit has been extinguished) is permitted.

The field coil 209, support member 208 and arcing electrode 224 which are common to the switches 201a and 201b, and the corresponding parts of the tee-off switch 201c are carried by a common insulating support 232 mounted on the housing 202. Moreover, the contact fingers 207 of all three switches are carried by a common support arm 206 which is in turn supported by the support 232. Again, the screening effect of the support members 208 is of particular importance since the coils 209 are shielded thereby against the effects of adjacent current-carrying conductors.

If desired, a fourth switch can be provided which shares the field coil and arcing electrode of the tee-off switch 201c in the same manner as described above in relation to the ring main switches 201a and 201b. Again, a mechanical interlock will be used to prevent simultaneous opening of the switches. Reference 233 shows in broken line the manner in which a conductor and bushing for the fourth switch would be arranged on the housing 202.

Figure 7 illustrates a number of modifications which can be applied, singly or in combination, to any of the embodiments described above. Those components or elements which correspond to the parts of the switchgear embodiments already described are denoted by the same reference numerals as used in Figures 1 and 2 but with 300 added, and will not in general be described again.

In Figure 7, a cranked contact arm 312 is used instead of a straight one, the arm being pivoted at a point spaced from the axis of the field coil 309 so that in the open position of the switch the end portion 319 of the contact arm not only lies along the axis of the field coil but also extends into the adjacent end of the arcing electrode 324. This arrangement helps in transferring the arc from the contact fingers 307 to the electrode 324, and brings the arc within the coil where the magnetic field is more concentrated.

The arcing electrode 324 has a radial flange 340 at an end thereof which faces the contact arm 312. The arrangement as illustrated is not suited to being shared between two switches: however, the provision of a flange at the other end of the electrode to give a symmetrical construction and the addition of a central insulating member similar to that referenced 231 in Figure 6 will enable the arrangement to be made common to two switches.

The field coil 309 is helically, rather than spirally, wound. If the coil is to be shared between two switches, it is to be appreciated that the inherent asymmetry of the helical coil may result in some difference in operating characteristics between the two switches. Because the helical coil 309 is not self-supporting, a separate mechanical support is provided for the arcing electrode 324. This support can be in the form of an electrically-insulating member 342 as shown, or the coil can be cast onto the electrode using, for example, an epoxy resin.

An electrically conductive finger 343 is provided on the support arm 306 adjacent the contact fingers 307, the initial arc being drawn from this finger rather than from the contact fingers 307 when the contact arm 312 moves away from the latter. The finger 343 can thus be made of arc-resistant material, whereas this may not be desirable for the contact fingers 307.

Figures 8 and 9 show two modifications (usable singly or in combination) to the switchgear of Figures 1 and 2 but which can likewise be applied to the switchgear embodiments of Figures 3 to 6 and which can be used in combination with modifications shown in Figure 7. Components or elements shown in Figures 8 and 9 which correspond to parts described already are given the same reference numerals as used in Figures 1 and 2 but with 400 added, and will not in general be described again.

In Figures 8 and 9, an insulated supporting cup 450 is provided within the arcing electrode 424 and has mounted therein a ferromagnetic ring 451. The cup 450 shields the ring 451 from the arc, and the ring concentrates the magnetic field produced by the field coil 409 to aid arc extinction. The action of the ring is of particular benefit when breaking relatively low currents. For some applications of the switchgear, it may be desirable to permit a flow of gas axially through the electrode 424, and for this reason, the supporting cup 450 can be made of annular configuration as indicated in broken line in Figure 8.

A ferromagnetic yoke 452 is provided to concentrate the magnetic field to encourage the initial arc to stay at the end of the contact arm 412 to facilitate transfer to the electrode 424. If desired, the yoke 452 can be covered in insulating material (for example, epoxy resin) to enable it to be placed close to the initial arc. The yoke enhances the action of the electromagnetic loop defined by the contacts and the arc.

Figure 10 shows schematically how the features shown in Figures 6 and 7 can be combined to produce ring main switchgear of compact form. A metal housing 500 filled with sulphur hexafluoride gas has mounted therein two ring main switches 501 and 502 which share a common field coil assembly 503 and a tee-off circuit breaking or load break switch 504 (which has a similar function to the switch 201c in the embodiment of Figure 6) which has an associated field coil assembly 505. The field coil assemblies 503 and 505 and fixed contact assemblies 506 for the various switches are all carried by a common insulating support 507. An insulating member 507' is provided transversely of the shared coil assembly 503 to so late the contact arms of the ring main switches 501 and 502 from one another when in their open positions. If desired, a fourth switch whose bushing is indicated in broken line at 508 can also be provided to share the field coil assembly 505 with the switch 504. The conductor bushings for the switches 501, 502 and 504 can be arranged radially of the housing 500 as shown in full lines, or tangentially of the housing as indicated in broken lines.

If desired, features shown in Figures 8 and 9 can also be provided in this arrangement.

As an alternative to the use of circular cross-section components, the contact arms on the embodiments of Figures 1 to 10 can be of rectangular cross-section, and the field coil and arcing electrode can be of oval cross-section.

The use of a rectangular cross-section arm is advantageous in that any burning caused by the arc upon opening of the switch under fault conditions occurs at the corners of the contact arm, the side surfaces of the contact arm which engage the fixed contact fingers in the closed position of the switch being substantially unaffected by such burning.

The invention has other applications besides the distribution switchgear described above. It is applicable to the control of industrial circuits and to distribution and transmission circuits at higher voltages. It can also be supplied to circuit breakers and switches having an insulated enclosure.

Claims

1. Electrical switchgear employing an electrically insulating fluid for arc extinction in which during opening of the switchgear contacts an arc is formed between a first contact (12) in the form of a contact arm and a tubular arcing electrode (24) the arcing current flowing through a field coil (9) connected electrically in series with the arcing electrode (24) to produce a magnetic field which causes the arc to rotate with one root thereof maintained on the first contact (12) and to become extinguished, the first contact (12) engaging a second contact (7) disposed externally of the field coil (9) in the contacts closed position of the switchgear, one of the first and second contacts (12, 7) being pivotable about an axis transverse to the axis of the field coil (9) and having an end portion (19) which moves transversely of the field coil axis, such that an initial arc is drawn across a pole face of the field coil (9) between the first and second contacts (12, 7) during movement of the contacts to their open position, and during further movement of the contacts towards said open position the arc is caused to transfer its other root from the second contact (7) to the tubular arcing electrode (24) by the action of the end portion (19) of said one of the contacts passing within a short distance from the arcing electrode (24), characterised in that the second contact (7) is positioned adjacent to the tubular arcing electrode (24); the first contact (12) is elongate and is pivoted at a point remote from said end portion (19) at a point on the field coil axis external to the field coil (9) so as to be pivotable about said transverse axis; the end portion (19) of the first contact (12) moves towards the field coil axis as the contacts move towards said open position; and the end portion (19) lies along the field coil axis with the end portion (19) remote from the pivot being disposed at a pole face of the field coil (9) when the contacts are in their fully open position.

2. Electrical switchgear according to Claim 1, further comprising a preferably annular ferromagnetic member (451) disposed at least partly within the field coil (409) to concentrate the magnetic field produced by the latter.

3. Electrical switchgear according to Claim 2 wherein the arcing electrode (424) has the ferromagnetic member (451) disposed therein.

4. Electrical switchgear according to any preceding Claim, wherein a ferromagnetic yoke (452) is associated with the second contact (407) to assist in positioning the initial arc on the end portion (419) of the first contact (412).

5. Electrical switchgear according to any preceding Claim, wherein the field coil (9) is composed of a self-supporting strip of conducting material arranged in a spiral, an outer end of the spiral being attached to mounting means (8) and an inner end thereof being attached to the arcing electrode (24).

6. Electrical switchgear according to any preceding Claim, wherein the turns of the field coil (9) run about the outside of the arcing electrode (24).

7. Electrical switchgear according to Claim 6, where in the arcing electrode (324) has a flange (340) which faces the first contact (312).

8. Electrical switchgear according to any preceding Claim, including two switches (201a, 201b) each of which has respective first and second contacts (212, 207), the switches sharing a common field coil (209) on opposite sides of which the first contacts are respectively disposed.

9. Electrical switchgear according to Claim 8, wherein the arcing electrode (224) is common to both switches (201a, 201b).

10. Electrical switchgear according to Claim 8 or 9, wherein an insulating member (231) is arranged transversely within the arcing electrode (224).

11. Electrical switchgear according to any preceding Claim, including a plurality of switches (201a, 201b, 201c) each having respective first and second contacts (212, 207), the second contacts (207) being mounted on a common insulating support (232).

12. Electrical switchgear according to Claim 11, including three switches (201a, 201b, 201c) and two field coils (209), one of the field coils being shared between two of the switches (201a, 201b).

13. Electrical switchgear according to Claim 12, including four switches and two field coils, each field coil being common to a respective paid of the switches.

14. Electrical switchgear according to any one of Claims 1 to 7, including a plurality of switches (101a, 101b, 101c) each having a respective field coil (109) and a respective arcing electrode (124), the switches being disposed substantially on a common axis (127) with the field coils (109) mutually staggered transversely of said axis.

15. Electrical switchgear according to Claim 14, including three switches (101a, 101b, 101c) whose associated field coils (109) are disposed in a triangular array.

16. Electrical switchgear according to any preceding Claim, wherein the electrically insulating fluid is a highly insulating gas, preferably sulphur hexafluoride.

17. Electrical switchgear employing an electrically insulating fluid for arc extinction in which during opening of the switchgear contacts an arc is formed between a first contact (312) in the form of a contact arm and a tubular arcing electrode (324), the arcing current flowing through a field coil (309) connectioned electrically in series with the arcing electrode (324) to produce a magnetic field which causes the arc to rotate with one root thereof maintained on the first contact (312) and to become extinguished, the first contact (312) engaging a second contact (307) disposed externally of the field coil (309) in the contacts closed position of the switchgear, one of the first and second contacts (312, 307) being pivotable about an axis transverse to the axis of the field coil (309) and having an end portion (319) which moves transversely of the field coil axis, such that an initial arc is drawn across a pole face of the field coil (309) between the first and second contacts (312, 307) during movement of the contacts to their open position, and during further movement of the contacts towards said open position the arc is caused to transfer its other root from the second contact (307) to the tubular arcing electrode (324) by the action of the end portion (319) of said one of the contacts passing within a short distance from the arcing electrode (324), characterised in that the second contact (307) is positioned adjacent to the tubular arcing electrode (324); the first contact (312) is cranked and is pivoted at an end thereof remote from said end portion (319) at a point (313) external to the field coil and spaced from the field coil axis; the end portion (319) of the first contact (312) moves towards the field coil axis as the contacts move towards said open position; and the end portion (319) lies along the field coil axis with the end of the portion (319) remote from the pivot extending into the field coil (309) when the switchgear is fully open.

Patentansprüche

1. Elektrische Schaltanlage, mit einem elektrisch isolierenden Fluid zur Lichtbogenlöschung, bei welcher während des Öffnens der Schaltanlagenkontakte ein Lichtbogen zwischen einem ersten Kontakt (12) in Form eines Kontaktarmes und einer rohrförmigen Lichtbogenelektrode (24) gebildet ist, wobei der Lichtbogenstrom durch eine Feldspule (9) fließt, die elektrisch in Reihe mit der Lichtbogenelektrode (24) verbunden ist und so ein Magnetfeld erzeugt, das bewirkt, daß der Lichtbogen um seinen einen am ersten Kontakt (12) gehaltenen Fuß rotiert und gelöscht wird, bei welcher der erste Kontakt (12) mit einem zweiten außerhalb der Feldspule (9) angeordneten Kontakt (7) in der geschlossenen Kontaktstellung der Schaltanlage in Wirkverbindung ist, bei welcher der erste oder der zweite Kontakt (12, 7) um eine Achse schräg zur Achse der Feldspule (9) schwenkbar ist und einen Endbereich (19) aufweist, der sich quer zur Feldspulenachse bewegt, derart, daß während der Bewegung der Kontakte in ihre offene Stellung ein Anfangslichtbogen über eine Polfläche der Feldspule (9) zwischen dem ersten und dem zweiten Kontakt (12, 7) gezogen wird und während der weiteren Bewegung der Kontakte zur offenen Stellung hin bewirkt wird, daß der andere Fuß des Lichtbogens vom zweiten Kontakt (7) zur rohrförmigen Lichtbogenelektrode (24) hin durch die Wirkung des Endbereichs (19) des einen der Kontakte, der sich in einem geringen Abstand zur Lichtbogenelektrode (24) vorbeibewegt, übergeben wird, dadurch gekennzeichnet, daß der zweite Kontakt (7) der rohrförmigen Lichtbogenelektrode (24) benachbart angeordnet ist, daß der erste Kontakt (12) länglich ausgebildet und um einen Punkt, der von diesem Endbereich (19) entfernt ist, an einem Ort auf der Feldspulenachse außerhalb der Feldspule (9) geschwenkt ist und so um die Querachse schwenkbar ist, daß der Endbereich (19) des ersten Kontaktes (12) sich zur Feldspulenachse hin bewegt wenn sich die Kontakte in die offene Stellung bewegen, und daß der Endbereich (19) längs der Feldspulenachse liegt und dabei von der Schwenkachse entfernt, an einer Polfläche der Feldspule (9) angeordnet ist, wenn die Kontakte in ihrer vollständig offenen Position sind.

2. Elektrische Schaltanlage nach Anspruch 1, dadurch gekennzeichnet, daß sie ferner ein vorzugsweise ringförmiges ferromagnetisches Element (451) aufweist, das zumindest teilweise innerhalb der Feldspule (409) angeordnet ist und

das von der letzteren erzeugte Magnetfeld konzentriert.

3. Elektrische Schaltanlage nach Anspruch 2, dadurch gekennzeichnet daß das ferromagnetische Element (451) in der Lichtbogenelektrode (424) angeordnet ist.

4. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß ein ferromagnetisches Joch (452) dem zweiten Kontakt (407) zugeordnet ist, um sicherzustellen, daß der Anfangslichtbogen am Endbereich (419) des ersten Kontaktes (412) positioniert ist.

5. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Feldspule (9) durch einen selbsttragenden Streifen aus in einer Spirale angeordnetem leitendem Material gebildet ist, wobei ein äußeres Ende der Spirale mit einer Haltevorrichtung (8) und ein inneres Ende von ihr mit der Lichtbogenelektrode (24) fest verbunden ist.

6. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Windungen der Feldspule (9) um die Außenseite der Lichtbogenelektrode (24) verlaufen.

7. Elektrische Schaltanlage nach Anspruch 6, dadurch gekennzeichnet, daß die Lichtbogenelektrode (324) einen Flansch (340) aufweist, der dem ersten Kontakt (312) gegenüberliegt.

8. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß er zwei Schalter (201a, 201b) aufweist, von denen jeder einen ersten und einen zweiten Kontakt (212, 207) besitzt, wobei den Schaltern eine gemeinsame Feldspule (209) zugeordnet ist, an deren einander abgewandten Seiten die ersten Kontakte jeweils angeordnet sind.

9. Elektrische Schaltanlage nach Anspruch 8, dadurch gekennzeichnet, daß die Lichtbogenelektrode (224) beiden Schaltern (201a, 201b) gemeinsam ist.

10. Elektrische Schaltanlage nach Anspruch 8 oder 9, dadurch gekennzeichnet, daß ein Isolierelement (231) in Querrichtung innerhalb der Lichtbogenelektrode (224) angeordnet ist.

11. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß er eine Vielzahl Schalter (201a, 201b, 201c) aufweist, von denen jeder einen entsprechenden ersten und zweiten Kontakt (212, 207) aufweist, wobei die zweiten Kontakte (207) an einem gemeinsamen Isolatorträger (232) gehalten sind.

12. Elektrische Schaltanlage nach Anspruch 11, dadurch gekennzeichnet, daß sie drei Schalter (201a, 201b, 201c) und zwei Feldspulen (209) aufweist, wobei eine der Feldspulen von zwei der Schalter (201a, 201b) gemeinsam verwendet ist.

13. Elektrische Schaltanlage nach Anspruch 12, dadurch gekennzeichnet, daß sie vier Schalter und zwei Feldspulen aufweist, von denen jede Feldspule einem Schalterpaar gemeinsam ist.

14. Elektrische Schaltanlage nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß sie eine Vielzahl Schalter (101a, 101b, 101c) aufweist, von denen jeder eine Feldspule (109) und eine Lichtbogenelektrode (124) aufweist, wobei die Schalter im wesentlichen auf einer gemeinsamen Achse (127) und die Feldspulen (109) quer zu dieser Achse gegenseitig versetzt angeordnet sind.

15. Elektrische Schaltanlage nach Anspruch 14, dadurch gekennzeichnet, daß sie drei Schalter (101a, 101b, 101c) aufweist, deren zugeordnete Feldspulen (109) dreieckförmig angeordnet sind.

16. Elektrische Schaltanlage nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das elektrisch isolierende Fluid ein hochisolierendes Gas, vorzugsweise Schwefelhexafluorid ist.

17. Elektrische Schaltanlage, mit einem elektrisch isolierenden Fluid zur Lichtbogenlöschung, bei welcher während des Öffnens der Schaltanlagenkontakte ein Lichtbogen zwischen einem ersten Kontakt (312) in Form eines Kontaktarmes und einer rohrförmigen Lichtbogenelektrode (324) gebildet ist, wobei der Lichtbogenstrom durch eine Feldspule (309) fließt, die elektrisch in Reihe mit der Lichtbogenelektrode (324) verbunden ist und so ein Magnetfeld erzeugt, das bewirkt, daß der Lichtbogen um seinen einen am ersten Kontakt (312) gehaltenen Fuß rotiert und gelöscht wird, bei welcher der erste Kontakt (312) mit einem zweiten außerhalb der Feldspule (309) angeordneten Kontakt (307) in der geschlossenen Kontaktstellung der Schaltanlage in Wirkverbindung ist, bei welcher der erste oder der zweite Kontakt (312, 307) um eine Achse quer zur Achse der Feldspule (309) schwenkbar ist und einen Endbereich (319) aufweist, der sich schräg zur Feldspulenachse bewegt, derart, daß während der Bewegung der Kontakte in ihre offene Stellung ein Anfangslichtbogen über eine Polfläche der Feldspule (309) zwischen dem ersten und dem zweiten Kontakt (312, 307) gezogen wird und während der weiteren Bewegung der Kontakte zur offenen Stellung hin bewirkt wird, daß der andere Fuß des Lichtbogens vom zweiten Kontakt (307) zur rohrförmigen Lichtbogenelektrode (324) hin durch die Wirkung des Endbereichs (319) des einen der Kontakte der sich in einem geringen Abstand zur Lichtbogenelektrode (324) vorbeibewegt, übergeben wird, dadurch gekennzeichnet, daß der zweite Kontakt (307) der rohrformigen Lichtbogenelektrode (324) benachbart angeordnet ist, daß der erste Kontakt (312) gekröpft und an einem Ende, das von diesem Endbereich (319) entfernt ist, um einen Punkt (313) außerhalb der Feldspule (309) und in einem Abstand von der Feldspulenachse geschwenkt ist, daß der Endbereich (319) des ersten Kontaktes (312) sich zur Feldspulenachse hin bewegt, wenn sich die Kontakte in die offene Stellung bewegen, und daß der Endbereich (319) längs der Feldspulenachse liegt und dabei von der Schwenkachse entfernt ist und sich in die Feldspule (309) hinein

erstreckt, wenn die Schaltanlage vollständig geöffnet ist.

Revendications

1. Installation de commutation électrique utilisant un fluide électriquement isolant pour éteindre un arc, dans laquelle, lors de l'ouverture des contacts de l'installation de commutation, un arc est formé entre un premier contact (12) sous forme d'un bras de contact et une électrode (24) de formation d'arc tubulaire, le courant de formation de l'arc circulant à travers une bobine de champ (9) connectée électriquement en série à l'électrode (24) de formation d'arc pour produire un champ magnétique qui fait tourner l'arc avec une racine de ce dernier maintenue sur le premier contact (12) et pour l'éteindre, le premier contact (12) venant en contact avec un second contact (7) disposé extérieurement à la bobine de champ (9) dans la position fermée des contacts de l'installation de commutation, un des premier et second contacts (12, 7) pouvant pivoter autour d'un axe transversal à l'axe de la bobine de champ (9) et présentant une portion d'extrémité (19) qui se déplace transversalement par rapport à l'axe de la bobine de champ, de telle sorte qu'un arc initial soit établi en travers d'une face polaire de la bobine de champ (9) entre les premier et second contacts (12, 7) lors du mouvement des contacts à leur position ouverte, et pendant la poursuite du mouvement des contacts vers la position ouverte, il est fait en sorte que l'arc transfère son autre racine à partir du second contact (7) vers l'électrode de formation d'arc tubulaire (24) par l'action de la portion d'extrémité (19) de l'un des contacts passant à une courte distance en éloignement de l'électrode (24) de formation d'arc, caractérisée en ce que le second contact (7) est positionné de façon contiguë à l'électrode de formation d'arc tubulaire (24) le premier contact (12) est allongé et est mis en pivotement en un point éloigné de la portion d'extrémité (19) en un point sur l'axe de bobine de champ extérieur à la bobine de champ (9) de façon à pouvoir pivoter autour de l'axe transversal la portion d'extrémité (19) du premier contact (12) se déplace vers l'axe de bobine de champ de sorte que les contacts se déplacent vers la position ouverte et la portion d'extrémité (19) se situe le long de l'axe de la bobine de champ avec la portion d'extrémité (19) éloignée du pivot disposée sur une face polaire de la bobine de champ (9) lorsque les contacts sont dans leur position entièrement ouverte.

2. Installation de commutation électrique selon la revendication 1, comprenant de plus un élément ferromagnétique de préférence annulaire (451), disposé au moins partiellement à l'intérieur de la bobine de champ (409) pour concentrer le champ magnétique produit par cette dernière.

3. Installation de commutation électrique selon la revendication 2, dans laquelle l'électrode de formation d'arc (424) comporte l'élément ferromagnétique (451) disposé dans celle-ci.

4. Installation de commutation électrique selon l'une quelconque des revendications précédentes, dans laquelle une culasse ferromagnétique (452) est associée au second contact (407) pour faciliter le positionnement de l'arc initial sur la portion d'extrémité (419) du premier contact (412).

5. Installation de commutation électrique selon l'une quelconque des revendications précédentes, dans laquelle la bobine de champ (9) est constituée d'une bande auto-supportée de matière conductive agencée en spirale, une extrémité extérieure de la spirale étant fixée à des moyens de montage (8) et une extrémité intérieure de cette dernière étant fixée à l'électrode (24) de formation de l'arc.

6. Installation de commutation électrique selon l'une quelconque des revendications précédentes, dans laquelle les spires de la bobine de champ passent sur l'extérieur de l'électrode (24) de formation de l'arc.

7. Installation de commutation électrique selon la revendication 6, dans laquelle l'électrode (324) de formation d'arc comporte une aile (340) qui fait face au premier contact (312).

8. Installation de commutation électrique selon l'une quelconque des revendications précéderites, comprenant deux commutateurs (201a, 201b) dont chacun possède des premier et second contact (212, 207), ces commutateurs desservant une bobine de champ commune (209) sur les côtés opposés de laquelle sont respectivement disposés les premiers contacts.

9. Installation de commutation électrique selon la revendication 8, dans laquelle l'électrode de formation d'arc (224) est commune aux deux commutateurs (201a, 201b).

10. Installation de commutation électrique selon la revendication 8 ou 9, dans laquelle un élément isolant (231) est disposé transversalement à l'intérieur de l'électrode de formation d'arc (224).

11. Installation de commutation électrique selon l'une quelconque des revendications précédentes, comprenant plusieurs commutateurs (201a, 201b, 201c) chacun d'entre eux possédant des premier et second contacts respectifs (212, 207), les seconds contacts (207) étant montés sur un support isolant commun (232).

12. Installation de commutation électrique selon la revendication 11, comprenant trois commutateurs (201a, 201b, 201c) et deux bobines de champ (209), l'une des bobines de champ étant répartie encre deux des commutateurs (201a, 201b).

13. Installation de commutation électrique selon la revendication 12, comprenant quatre commutateurs et deux bobines de champ, chaque bobine de champ étant commune à une paire respective de commutateurs.

14. Installation de commutation électrique selon l'une quelconque des revendications 1 à 7, comprenant plusieurs commutateurs (101a, 101b,

101c) chacun d'entre eux comportant une bobine de champ respective (109) et une électrode de formation d'arc respectif (124), les commutateurs étant disposés sensiblement sur un axe commun (127) avec les bobines de champ (109) mutuellement disposées en quinconce transversalement à cet axe.

15. Installation de commutation électrique selon la revendication 14, comprenant trois commutateurs (101a, 101b, 101c) dont les bobines de champ associées (109) sont disposées dans une zone triangulaire.

16. Installation de commutation électrique selon l'une quelconque des revendications précédentes, dans laquelle le fluide isolant électriquement est un gaz hautement isolant, de préférence de l'hexafluorure de soufre.

17. Installation de commutation électrique utilisant un fluide isolant électriquement pour l'extinction de l'arc, dans laquelle, pendant l'ouverture des contacts de l'installation de commutation, un arc est formé entre un premier contact (312) sous forme d'un bras de contact et une électrode de formation d'arc tubulaire (324), le courant de formation d'arc circulant à travers une bobine de champ (309) reliée électriquement en série à l'électrode de formation d'arc (324) pour produire un champ magnétique qui fait tourner l'arc avec une racine de ce dernier maintenue sur le premier contact (312) et pour s'éteindre, le premier contact (312) venant, en contact avec un second contact (307) disposé extérieurement de la bobine de champ (309) dans la position fermée des contacts de l'installation de commutation, l'un des premier et second contacts (312, 307) pouvant pivoter autour d'un axe transversal à l'axe de la bobine de champ (309) et présentant une portion d'extrémité (319) qui se déplace transversalement par rapport à l'axe de la bobine de champ, de telle sorte qu'un arc initial est établi en travers d'une face polaire de la bobine de champ (309) entre les premier et second contacts (312, 307), le mouvement des contacts sur leur position ouverte, et pendant la poursuite du mouvement des contacts vers la position ouverte, l'arc doit transférer son autre racine à partir du second contact (307) vers l'électrode de formation d'arc tubulaire (324) sous l'action de la portion d'extrémité (319) de celui des contacts passant à une courte distance de l'électrode de formation d'arc (324), caractérisée en ce que le second contact (307) est positionné de façon contiguë à l'électrode de formation d'arc tubulaire (324) le premier contact (312) est coudé et il est mis en pivotement sur son extrémité éloignée de la portion d'extrémité (319) en un point (313) extérieur à la bobine de champ et espacé de l'axe de bobine de champ la position d'extrémité (319) du premier contact (312) se déplace vers l'axe de la bobine de champ lorsque les contacts se déplacent vers la position ouverte; et la position d'extrémité (319) se situe le long de l'axe de la bobine de champ avec l'extrémité de la portion (319) éloignée du pivot s'étendant jusque dans la bobine de champ (309) lorsque l'installation de commutation est entièrement ouverte.

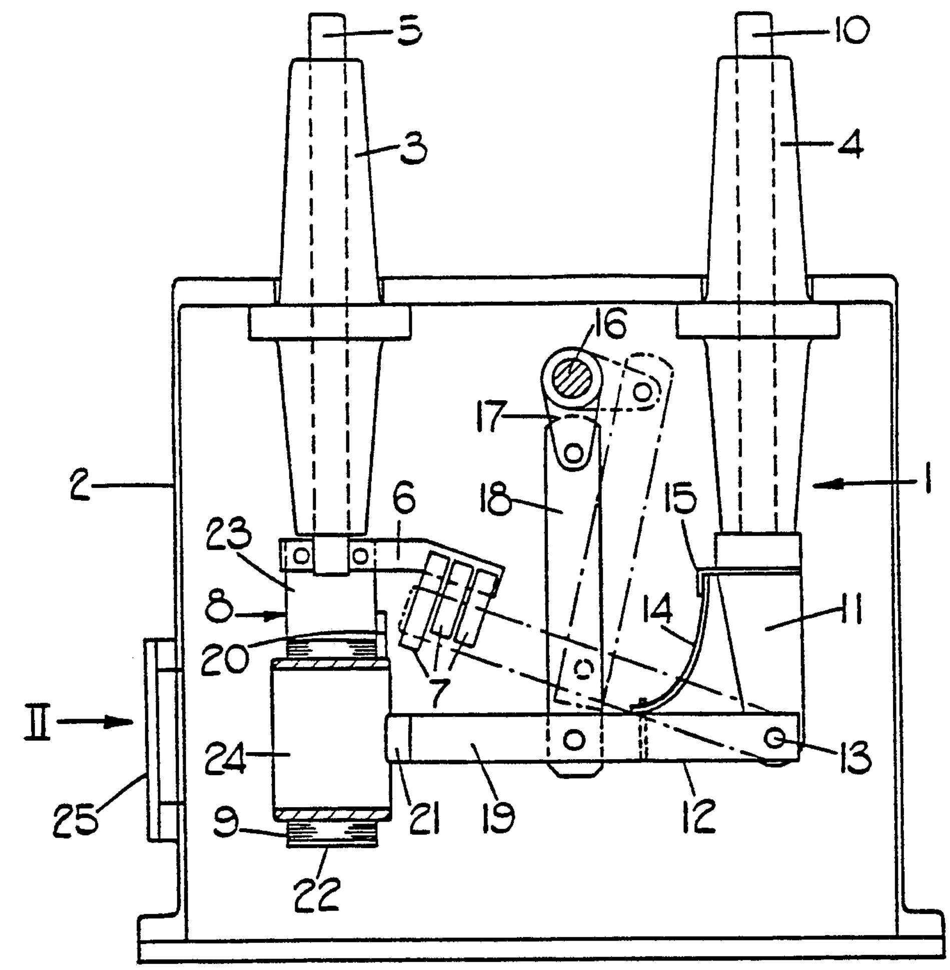

5
10
3
4
16
17
18
1
2
6
15
23
14
11
8
20
7
II
24
21
19
12
13
25
9
22

FIG.1.

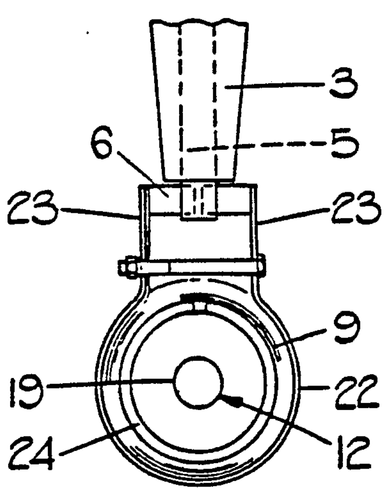
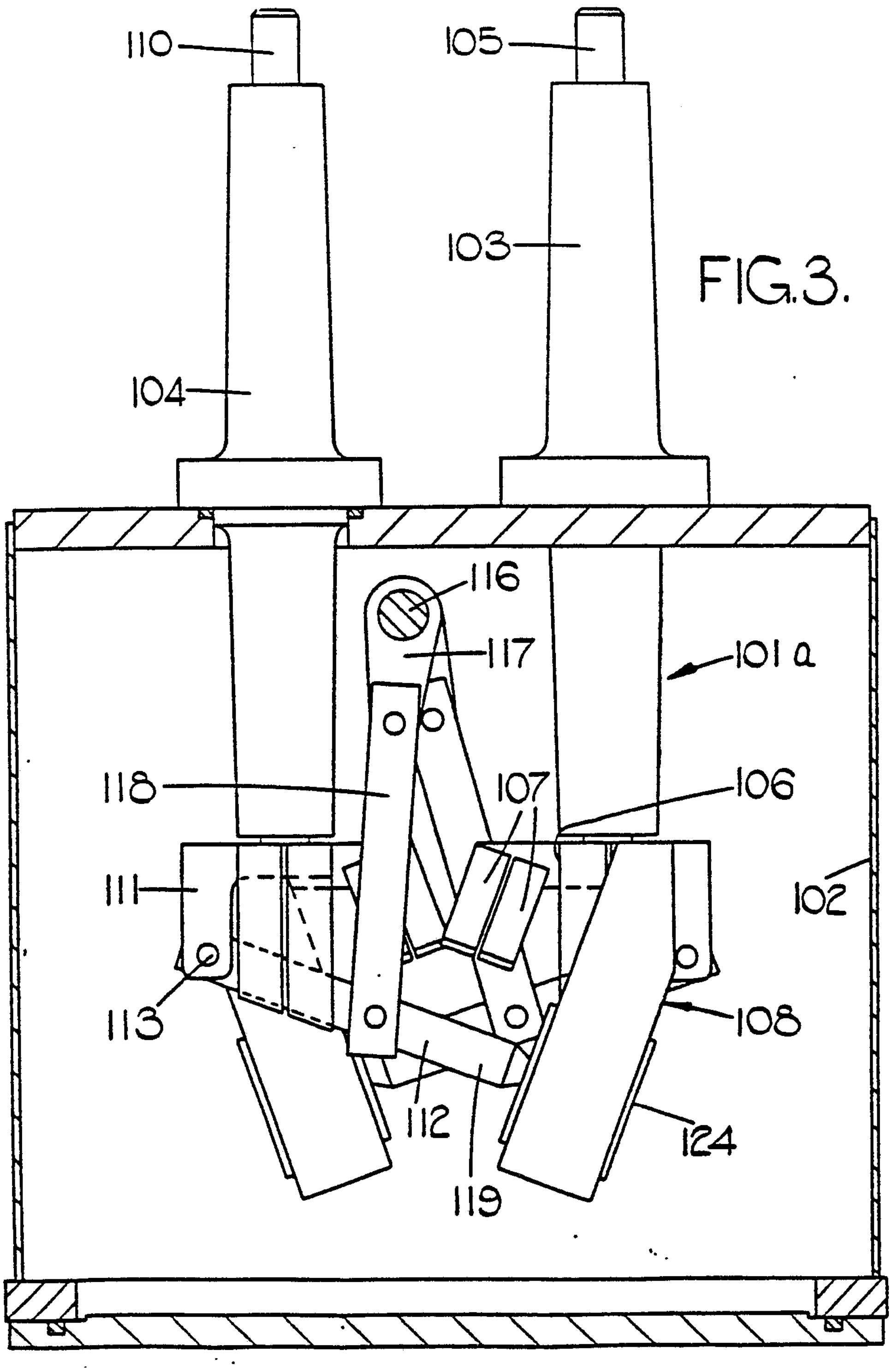

3
5
6
23
23
9
19
22
24
12

FIG.2.

FIG.3.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105
103
104
116
117
101 a
118
107
106
111
102
113
108
112
124
119

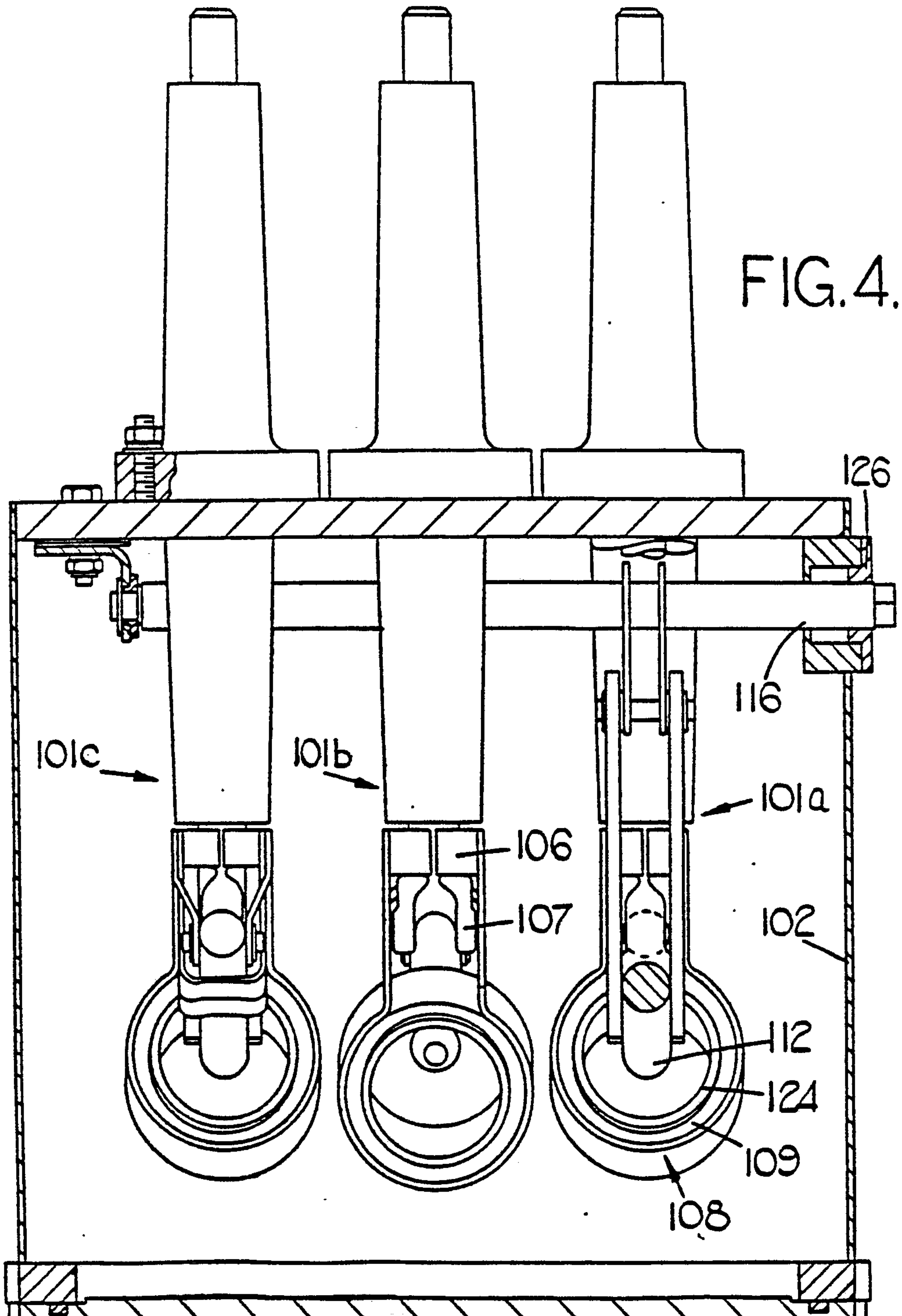


FIG. 4.

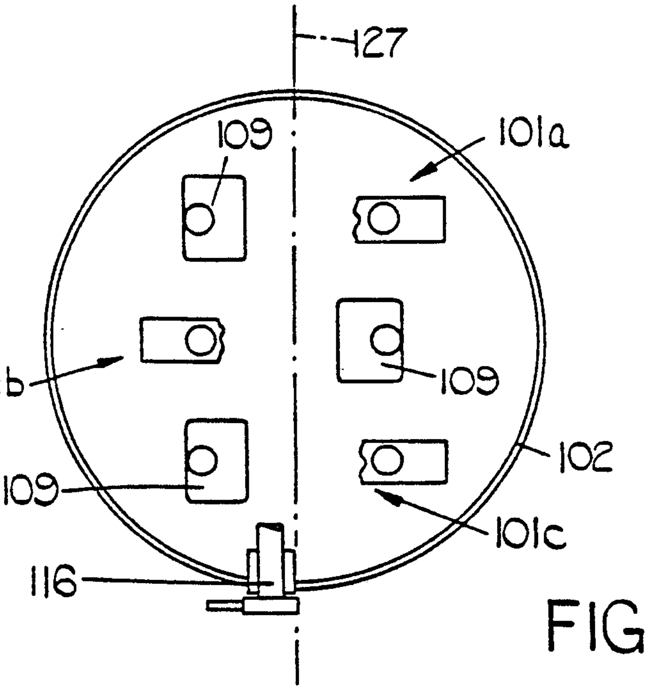
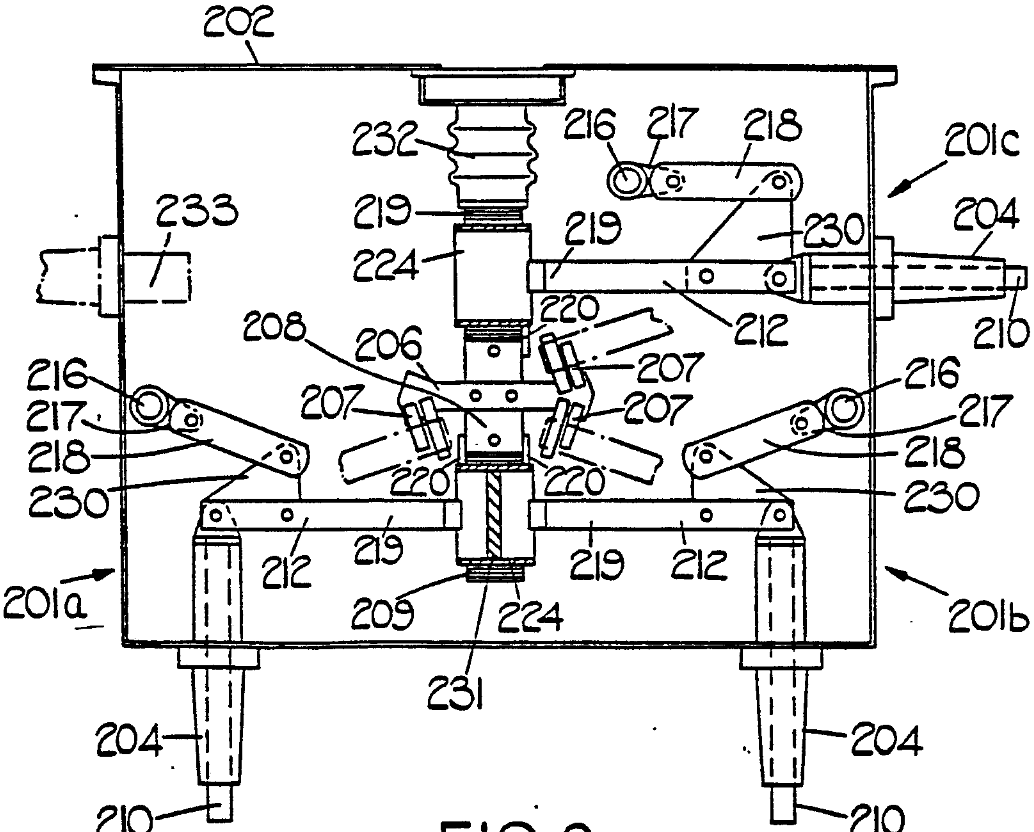

127
109
101a
101b
109
102
109
101c
116

FIG.5.


202
232
216
217
218
201c
233
219
219
230
204
224
220
212
210
208
206
207
216
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217
217
207
207
218
218
230
220
220
230
212
219
219
212
212
201a
209
224
201b
231
204
204
210
210

FIG.6.

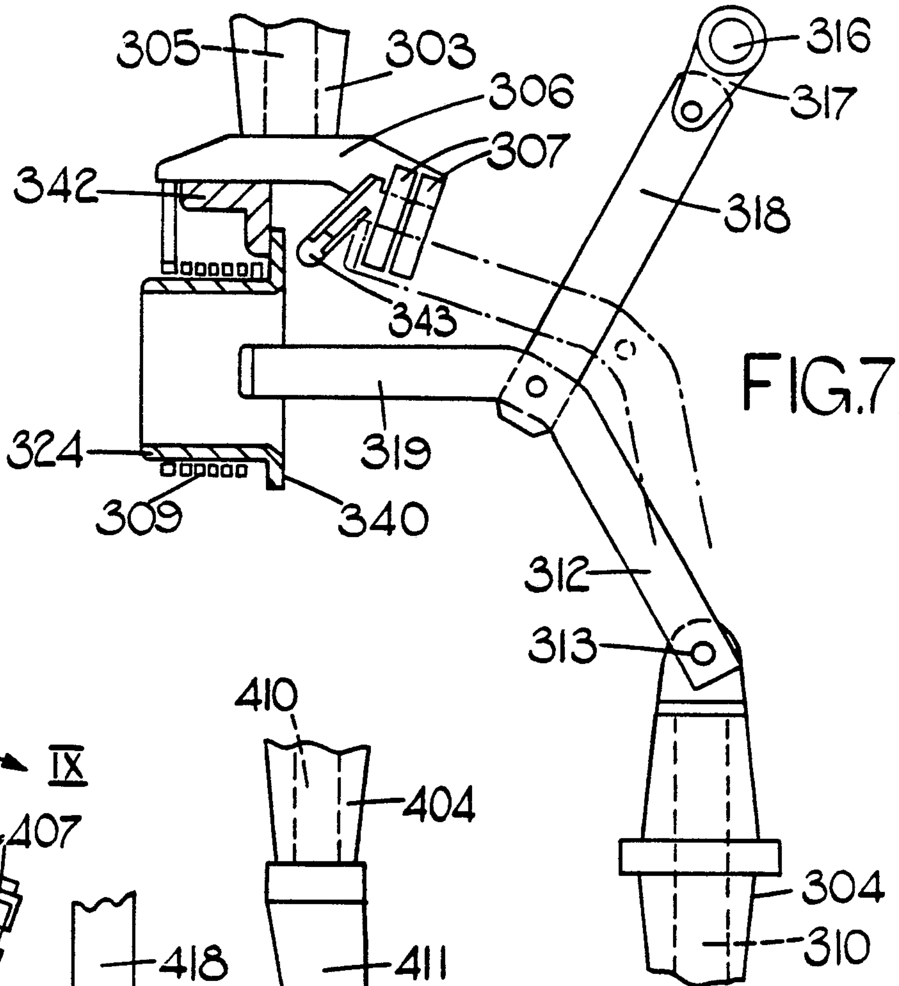

FIG.7.

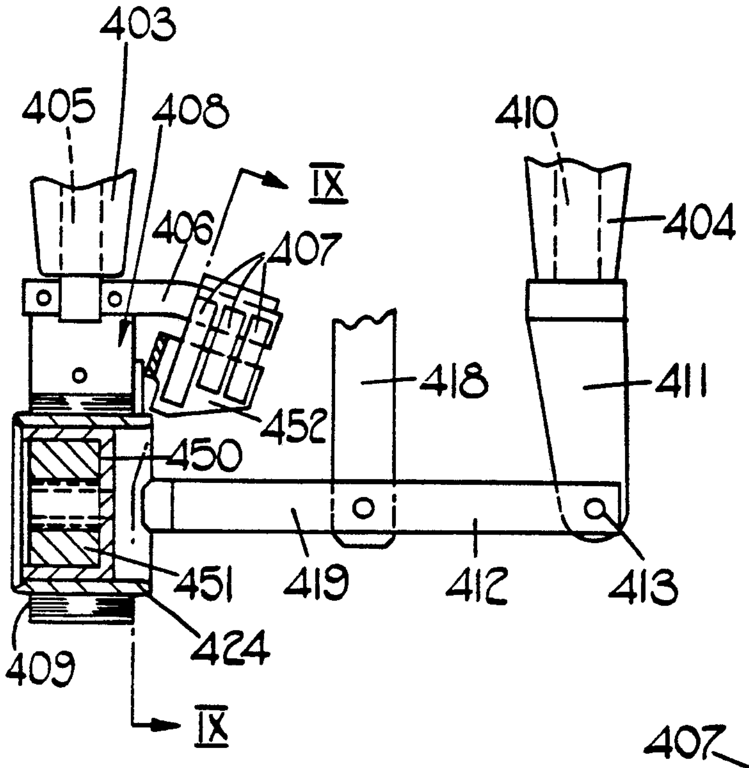

FIG.8.

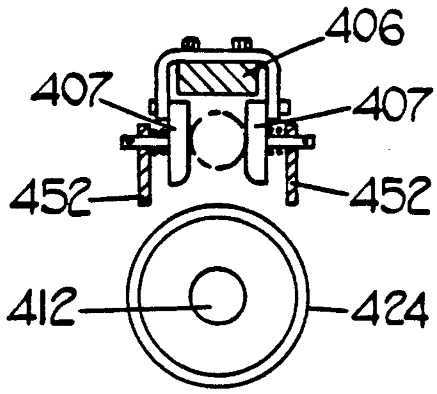

FIG.9.

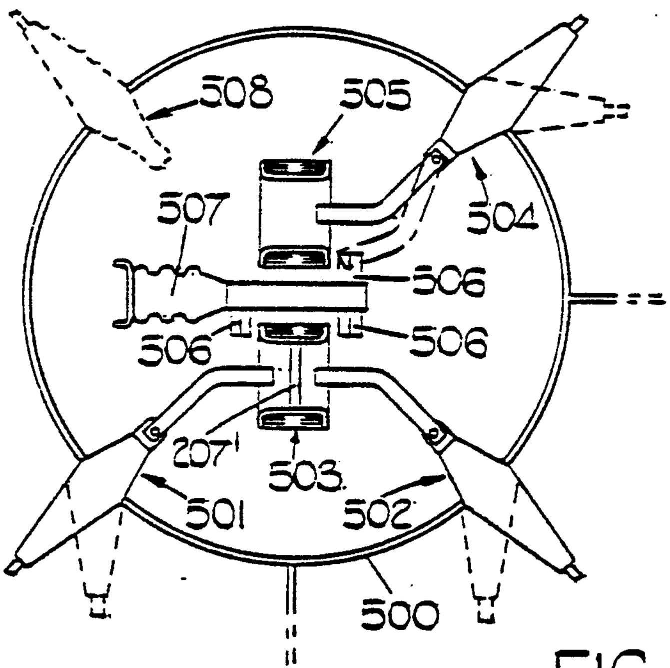

FIG.10.