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VACUUM TUBE INTERRUPTER HAVING SEQUENTIAL SEPARABLE CONTACTS

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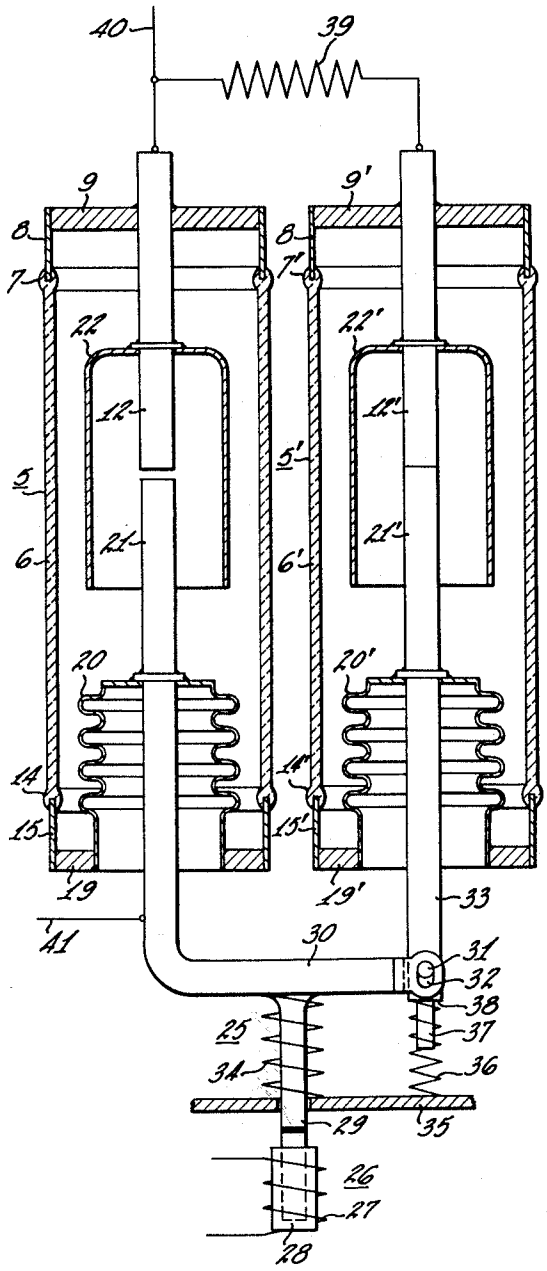

Fig. 1

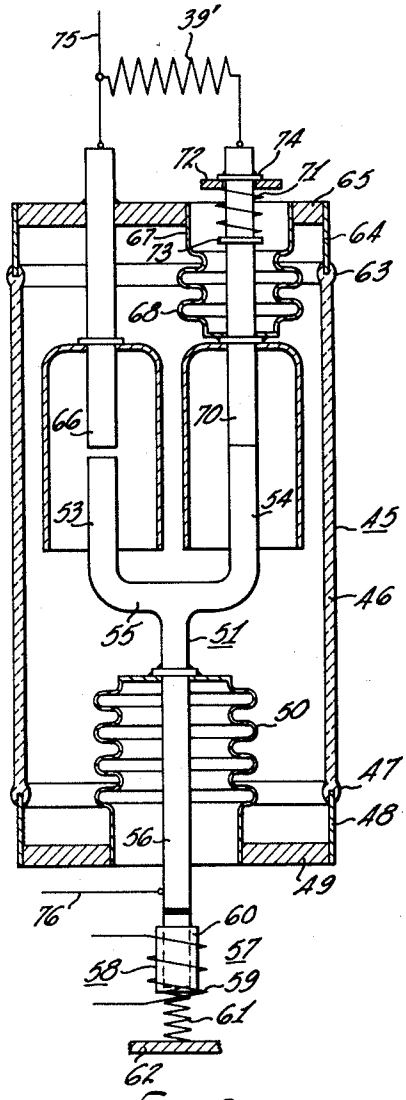

Fig. 2

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VACUUM TUBE INTERRUPTER HAVING SEQUENTIAL SEPARABLE CONTACTS

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1 Claim. (Cl. 200—144)

This invention relates to vacuumized electrical devices and more particularly to a new and improved switching arrangement employing a plurality of vacuum switches electrically and mechanically interconnected.

In accordance with the invention claimed a new and improved circuit breaker is provided comprising at least a pair of interconnected circuit interrupting devices. Each of the devices is mounted within a vacuumized envelope and comprises a pair of cooperating separable contacts. At least one of the contacts of each of the pairs of contacts is supported for movement in contact opening and closing directions. Means are provided for electrically interconnecting the contacts and for sequentially separating the contacts in a given time relationship.

It is, therefore, one object of this invention to provide a new and improved vacuumized electric circuit interrupting device.

Another object of this invention is to provide a new and improved vacuumized circuit interrupting device employing a plurality of modules operated by a common actuating mechanism.

A further object of this invention is to provide a new and improved vacuumized circuit interrupting device employing a plurality of modules in which the contacts of the modules are actuated in sequence.

A still further object of this invention is to provide a new and improved vacuumized arrangement employing a plurality of modules in which the contacts of the modules are separated in a predetermined timed sequence with a current limiting means being inserted in the electrical circuit by the contacts to aid arc extinguishment.

A still further object of this invention is to provide a new and improved parallel arrangement of vacuum switch modules.

A still further object of this invention is to provide a new and improved vacuum switch arrangement in which a plurality of modules are arranged in a common vacuumized envelope.

Objects and advantages other than those set forth will be apparent from the following description when read in connection with the accompanying drawing in which:

FIG. 1 is an elevational view partly in axial section of a vacuum switch arrangement embodying the invention; and

FIG. 2 is an elevational view partly in axial section of a modification of the structure shown in FIG. 1.

Referring more particularly to the drawing by characters of reference FIG. 1 illustrates an electric switch comprising a pair of switch devices or modules 5 and 5'. Modules 5, 5' comprise cylindrical envelopes 6, 6', respectively, which may be formed, for example, of a suitable vitreous material. One end of each of envelopes 6, 6' is provided with annular rims 7, 7' respectively, to which is fixedly secured in gas tight connection thereto one end of rings or flanges 8, 8'. Metallic caps 9, 9' are sealed throughout their edges to the other ends of flanges 8, 8' respectively, in the manner shown in FIG. 1. The caps 9, 9' may be reentrant, protruding or flat as shown.

Caps 9, 9' support one end of fixed contacts 12, 12'. Contacts 12, 12' are arranged to extend along the longitudinal axis of envelopes 6, 6' and are substantially rigidly supported so as to restrict longitudinal or lateral movement thereof. Caps 9, 9' may support tubular venting passages (not shown) through which envelopes 6, 6' may be evacuated and sealed off in the usual manner, if so desired.

The opposite ends of envelopes 6, 6' are provided with annular rims 14, 14' to which are fixedly secured in vacuum tight connection one end of ring or flanges 15, 15'. Ringlike brackets 19, 19' arranged to extend inwardly of envelopes 6, 6' are sealed in vacuum tight connection to the other ends of flanges 15, 15' in the manner shown. Metallic cylindrically shaped bellows 20, 20' are fixedly secured in a vacuum tight connection at one end thereof to brackets 19, 19'. The other ends of bellows 20, 20' surround and are fixedly attached in vacuum tight connections to movable contacts 21, 21' which are arranged to extend into envelopes 6, 6' and into cooperating relationship with contacts 12, 12'.

The relatively movable cooperating contacts 12, 12' and 21, 21' may be made of any suitable material such as tungsten or tungsten alloy. In order to control the arcing products emitted upon separation of the engaging surfaces of contacts 12, 12' and 21, 21' cylindrical cup shaped tubes or shields 22, 22' are provided around and spaced from contacts 12, 12'. Shields 22, 22' are arranged to extend beyond the adjacent ends of the contacts so as to surround at least a part of contacts 21, 21' when in contact engaging position. Shields 22, 22' may be formed of glass or any suitable metallic or nonmetallic material.

As shown in FIG. 1, contacts 21, 21' are arranged for longitudinal movement through a limited predetermined distance by common contact actuating mechanism 25. Contact actuating mechanism 25 comprises a solenoid 26 comprising a coil 27, core 28 and armature 29. Armature 29 is fastened to a cross bar 30 which is attached to movable contacts 21, 21'. Bar 30 is provided with a bifurcated end defining a pair of leg members each having arranged therein a slot 32. A pin 31 on shaft 33 cooperates with slots 32 to form a lost motion or time delay connection so that when armature 29 is actuated in contact opening direction contacts 12 and 21 of module 5 separate in time sequence before contacts 12' and 21' of module 5' separate. As shown in FIG. 1 a biasing spring 34 is mounted axially around armature 29 to extend between bar 30 and a relatively fixed frame member 35. Spring 34 is arranged to bias armature 29 and contact 21 in contact closing direction. A spring 36 is axially arranged around an extension portion 37 of shaft 33 between a collar 38 of shaft 33 and frame member 35 to aid in biasing contact 21' in contact closing direction. The contact actuating mechanism 25 is operated at one end thereof and actuates the arcing contacts in a reciprocating manner at its other end inwardly and outwardly of their envelopes.

A resistance means comprising a resistor 39 is arranged to extend between contacts 12 and 12' of modulator 5, 5' as shown in FIG. 1.

In contact closed position current flows from conductor 40 through contacts 12 and 21 to conductor 41, and depending on the resistance value of resistor 39 through the parallel current path comprising resistor 39, contacts 12' and 21' and cross bar 30 to conductor 41. Upon energization of solenoid 26, armature 29 is actuated into core 28 to separate contacts 12 and 21 of module 5. After a predetermined time delay caused by the lost motion arrangement comprising slot 32 and pin 31, contacts 12' and 21' separate in timed sequence with the contacts 12, 21 of module 5.

Upon separation of contacts 12 and 21 of module 5 and immediately after momentary interruption at a current zero, the returning voltage between contacts 12, 21 causes current to flow through resistor 39 and contacts 12', 21' of module 5'. The magnitude of the current flowing through the interrupting circuit is decreased by the resistance value of resistor 39 and the difficulty of completely interrupting the current is greatly diminished,

particularly in the case of inductive circuits where chopping of the current at an extremely rapid rate leads to very high voltage surges which tends to damage the insulation of associated electrical apparatus such as motors and transformers. Advantages are obtained with the claimed structures generally in circuits having high rates of increase of the recovery voltage and also in the case of capacitance switching. The ohmic value of resistor 39 depends on the characteristics of the circuit to be controlled. The comparatively weak arc current through resistor 39 is finally extinguished by the separation of contacts 12' and 21' of module 5'.

FIG. 2 illustrates a modification of the structure shown in FIG. 1 wherein the electric switch 45 disclosed comprises a cylindrical envelope 46 which may be formed, for example, of a suitable vitreous material. One end of envelope 46 is provided with an annular rim 47 to which is fixedly secured in vacuum tight connection thereto one end of ring or flange 48. A metallic bracket 49 is arranged to extend inwardly of envelope 46 and is sealed in vacuum tight connection to the other end of flange 48 in the manner shown. Metallic cylindrically shaped bellows 50 is fixedly secured in a vacuum tight connection at one end thereof to bracket 49. The other end of bellows 50 surrounds and is fixedly attached in vacuum tight connection to a movable contact 51 which is arranged to extend into envelope 46. Movable contact 51 comprises a U-shaped member having a pair of legs 53 and 54 which are interconnected by a bight 55. Bight 55 is connected to a shaft portion 56. Shaft portion 56 of contact 51 extends through bellows 50 and out of envelope 46. Movable contact 51 is actuated by a mechanism 57 comprising a solenoid 58. Solenoid 58 comprises a coil 59, core 60 and armature which may be for example, shaft portion 56. The armature comprising shaft portion 56 is biased axially of envelope 46 into contact closed position by any suitable means such as spring biasing means 61 extending between a fixed member 62 and the end of shaft portion 56.

The opposite end of envelope 46 is provided with an annular rim 63 to which is sealed in vacuum tight connection one end of ring or flange 64. A metallic cap 65 is sealed throughout its edge to the other end of flange 64 and provides a support for one end of a fixed contact 66. Contact 66 is arranged in cooperating relationship with the end of leg 53 which forms the movable member of the cooperating arcing contact.

A reentrant bracket or tube member 67 is provided in cap 65, as shown in FIG. 2, in fluid tight connection therewith. The inward edge of the tube member 67 is sealed in vacuum tight connection to a metallic cylindically shaped bellows 68. The other end of bellows 68 surrounds and is fixedly attached in vacuum tight connection to a movable contact 70 which is arranged to extend through tube member 67 into envelope 46 and in cooperating relationship with the end of leg 54 which serves as a cooperating arcing contact.

Movable contact 70 is arranged for movement longitudinally of envelope 46 and is biased into engagement with leg 54 by a spring 71 arranged between a fixed member 72 and a flange 73 on movable contact 70. As movable contact 51 moves outwardly of envelope 46 in contact opening direction under the influence of the actuating mechanism 57, movable contact 70 moves together in contact engagement with leg 54 during a part of its travel until a collar 74 on contact 70 engages fixed member 72. At this point movable member 70 and leg 54 of movable contact 51 separate and remain separated for further outward movement of movable contact 51.

A resistor 39' is arranged between contacts 66 and 70 and is provided for the same reasons and serves the same function as resistor 39 of FIG. 1.

In contact closed position current flows from conductor 75 through contact 66, leg 53, bight 55 and shaft portion 56 of movable contact 51 to conductor 76 and depending on the resistance value of resistor 39' through the parallel current path comprising resistor 39', contact 70, leg 54, bight 55 and shaft portion 56 of movable contact 51 to conductor 76. Upon energization of solenoid 58 the armature comprising shaft portion 56 is actuated outwardly of envelope 46 into core 60 to separate contact 66 and leg 53. During this movement of movable contact 51, leg 54 is moved in contact opening direction but movable contact 70 follows along and in contact engagement with leg 54 a predetermined distance under the influence of spring 71. Upon further movement of contact 51 after collar 74 has engaged fixed member 72, contact 70 stops and the cooperating arcing contact formed by leg 54 separates from movable contact 70 to draw an arc. The magnitude of the current flowing through the movable contact 70 and leg 54 is decreased by the resistance value of resistor 39' in the same manner as described for resistor 39 in FIG. 1 to interrupt the power circuit.

Although but two embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claim.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

A circuit breaker comprising at least a pair of interconnected circuit interrupting devices, each of said devices being mounted within a common vacuumized envelope and each comprising a pair of cooperating separable contacts, at least one of said contacts of each of said pairs of contacts being supported for movement in directions inwardly and outwardly of said envelope, U-shaped means adapted to operate said movable contacts from one end of said envelope and for electrically connecting said movable contacts, time delay means for causing said movable contacts to separate in sequence, said time delay means comprising movable sealing means on said envelope, one other of said contacts of one of said pairs of contacts extending through said sealing means, and biasing means for biasing said one other contact whereby the contacts of one of said pairs of contacts move together in contact opening direction until the other of said pair of contacts separate, and resistance means conductively connected between the other of said pairs of contacts of said devices for aiding arc extinguishment.

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