March 3, 1964 F. WATERTON 3,123,698

CIRCUIT BREAKERS HAVING INTERRUPTING CONTACTS OPERATING IN A VACUUM

Filed Jan. 22, 1962 2 Sheets-Sheet 1

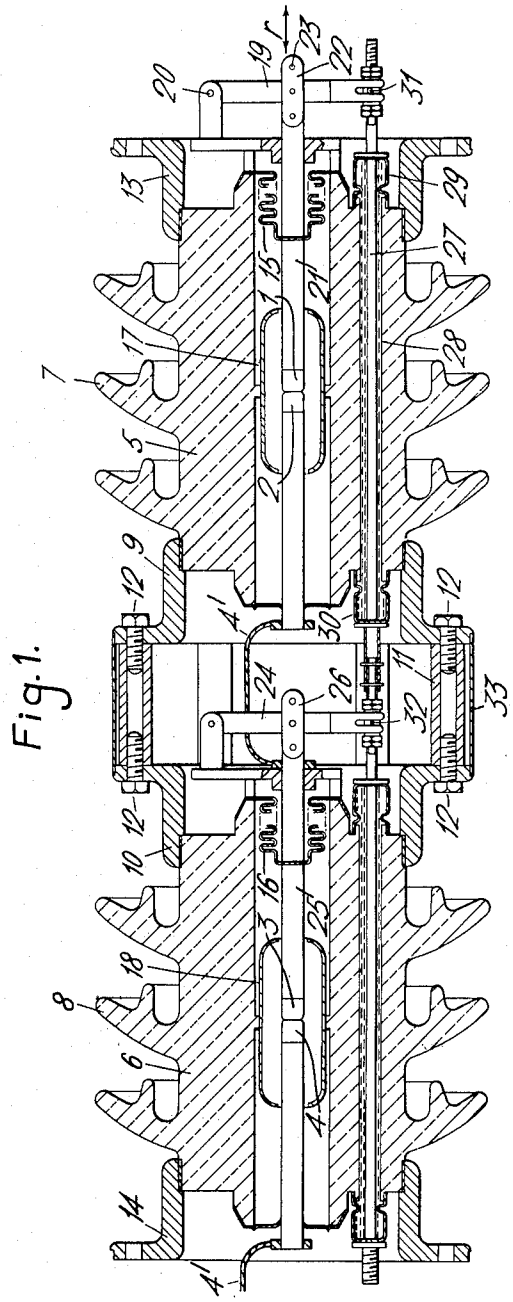


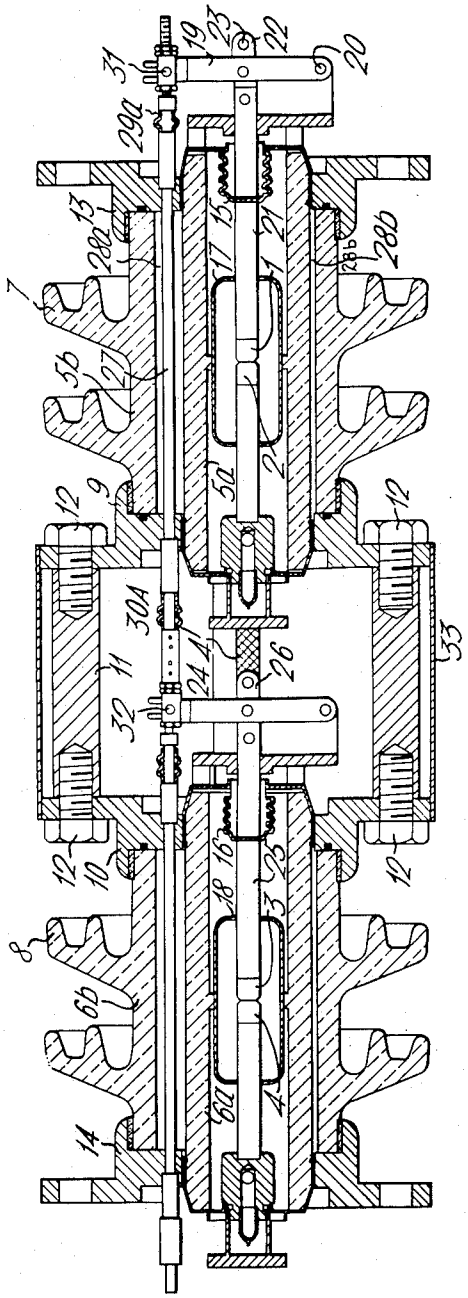
Fig. 1.

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Fig. 2.



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CIRCUIT BREAKERS HAVING INTERRUPTING CONTACTS OPERATING IN A VACUUM

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This invention relates to switch arrangements and aims at an improvement which is material-, weight-, and space-saving, also suitable for outdoor use, and to interrupt large currents at high voltages.

This is achieved by a particular series arrangement of "vacuum" switching, where the switching chamber contains a gas at a very low pressure.

Accordingly this invention resides in a switch arrangement having a co-operating movable and stationary contact pair connected in series with at least one other such contact pair, hollow insulators separately enclosing each one of said contact pairs being evacuated and sealed, a flexible conductor connecting the stationary contact of one pair to the movable contact of the other pair, and a longitudinal member movable parallel to the contact movement of one of said pairs, and transmitting this movement to the movable contact of the other of said pairs.

The longitudinal member is conveniently movable in a channel which has a wall of insulating material and is filled with an insulating fluid. The channel can be formed in the wall of the hollow insulator, or can comprise an annular space defined by the outer wall of the hollow insulator and the inner wall of an outer insulator, which is cylindrical but preferably eccentric to the said outer wall.

The hollow insulator may be of vitreous material, but is preferably of a ceramic material, e.g. porcelain. Sheds can be provided to increase the length of leakage path along the outer surface of the device.

The insulators enclosing each one of the series connected contact pairs are of similar shape, co-axially aligned, and secured together. Rings, and flanges of angle cross-section, can be employed for interconnecting the insulators, also for containing a mechanism for deriving the operation of the movable contact of one contact pair from the movement of a longitudinal member which controls the movable contact of another contact pair.

More details will become apparent and the invention will be better understood from the following description referring to FIGURES 1 and 2 of the accompanying drawing which show diagrammatically and by way of example two preferred embodiments of the invention, similar parts being denoted by similar reference characters.

Referring to FIG. 1, pairs of co-operating movable and stationary contacts denoted **1**, **2** and **3**, **4** respectively, are series connected through a flexible conductor **4'**. Separate envelopes or hollow insulators **5**, **6** of similar shape and provided with sheds **7**, **8** enclose the two contact pairs. Flange members **9**, **10** of angular cross-section, cemented to the hollow insulators **5**, **6**, and a tubular or ring portion **11** between the flanges are connected together, as by bolts **12**. An outer sheet-metal ring **33** is also provided. Thus a chamber is formed between the ends of insulators **5**, **6** which need not be evacuated and contains the conductor **4'**, and also a mechanism for operating the movable contact **3** as will be seen later. Flanges **13**, **14** similar to the flanges **9**, **10** are cemented to the right-hand end of insulator **5** and to the left-hand end of insulator **6**. The ends of the insulators are sealed and metal bellows **15**, **16** ensure air-tightness while the contacts **1**, **3** are moved by rods **21**, **25**, extending through

the bellows. A conductor **4'** could serve to connect another movable contact in series relationship to the contacts **1**, **3**. Advantageously arcing shields **17**, **18**, fastened to internal ribs of the insulators **5**, **6** and positioned in the vicinity of the movable contacts protect the wall of the insulator. For contact making and breaking movements as indicated by the arrows *r*, rod **21** carrying contact **1** is connected to an arm **19** through a link **22**. Arm **19** is pivoted at **20** to a stationary bracket. An external operating force may be applied to point **23** of the link **22**, or to the arm **19**. Rod **25** carrying the movable contact **3** extends through the bellows **16** and is operable through link **26** by arm **24** which is pivoted: It will be seen that the mechanisms operating contacts **1** and **3** are alike, except that the actuation of arm **24** is derived from arm **19** through an insulated operating rod **27**. This rod is contained in a space or channel **28** traversing longitudinally the wall of insulator **5**. The ends of the space or channel **28** are closed by caps **29**, **30**, which are resilient in the manner of membranes. The space between the rod **27** and wall **28** is filled with an insulating material, such as transformer oil or an insulating gas such as sulpho-hexa-fluoride or dichloro-difluoro-methane which have a high electric break-down strength, in order to avoid ionisation effects. Pins **31**, **32** positioned outside channel **28** on the operating rod **27** and within slots of arms **19**, **24** operationally interconnect the arms. Thus contact **3** is operated simultaneously with the contact **1**. In order to ensure simultaneous operation even when the temperature changes the rod **27** is made of the same material as the insulator **5**, or of a material having a similar temperature coefficient of expansion.

Alternatively, a fluid filling the channel in the insulator may serve as a hydraulic link between the two contact operating mechanisms. As the temperature coefficient of the fluid might differ considerably from that of the insulator suitable compensation must be provided for as is known in the art. For instance, the pivoting point of the arm may move in accordance with the change in length of a column of fluid similar to that in channel **28**, subjected to the same temperature changes.

The embodiment illustrated by FIG. 2 differs from the embodiment of FIG. 1 in that the channel for accommodating the longitudinal member **27** is formed in the ring space between inner and outer insulators. The inner insulators **5***a*, **6***a*, enclose the contact pairs **1**, **2**, and **3**, **4** respectively. The outer insulators **5***b*, **6***b* are provided with sheds **7**, **8**. The walls defining the ring space between them are cylindrical, but not coaxial, and the longitudinal member **27** is situated in the zone **28***a* of the ring space which is wider than the zone **28***b* of the ring space diametrically opposite to the zone **28***a*. The ring space is hermetically sealed and bellows **29***a*, **30***a* are provided to allow longitudinal movement of the member **27**. Parts corresponding to those of FIG. 1 are denoted by similar reference characters, and the switches in series circuit relationship with each other are conveniently of similar construction.

While preferred embodiments of the invention have been shown it will be understood that modifications are possible without departing from this invention. The operation of the series connected contacts need not be simultaneous, and a time delay can be introduced. A contact shunted by a high impedance may be disengaged shortly after a parallel contact not so shunted has disengaged. Where the motion transmitting member comprises a fluid column, a restricting orifice can be provided to introduce a time delay.

What I claim is:

1. A circuit breaker comprising interrupting contacts for operating in an envelope forming a vacuum, at least two sets of such contacts being electrically series con-

nected and enclosed in an insulator forming separate envelopes which are evacuated, sealed and aligned in the direction of contact opening, an intermediate enclosure connecting said separate envelopes by being sealed to the neighboring ends of adjacent separate envelopes, a mechanism for causing operation of the interrupting contacts comprising an insulating rod for each said envelope, each of said rods being situated parallel to said direction of contact opening and enclosed and sealed in a separate sealed channel, said separate sealed channels being filled with a medium of an insulating quality substantially higher than that of air and thus sealed to prevent pollution and ingress of humidity from the outer atmosphere, each of said separate envelopes of said insulator including a cylindrical hollow the opposite ends of which are closed by separate covers, and each of said separate sealed channels being positioned in a wall of each one of the said insulators and parallel to said cylindrical hollow.

2. The circuit breaker of claim 1 wherein the two rods in the two channels of two neighboring insulators are mechanically interconnected in said intermediate enclosure outside the said channels, and a lever means in said intermediate enclosure is provided for transmitting movement from a connecting point to the interrupting contacts in one of said separate envelopes.

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