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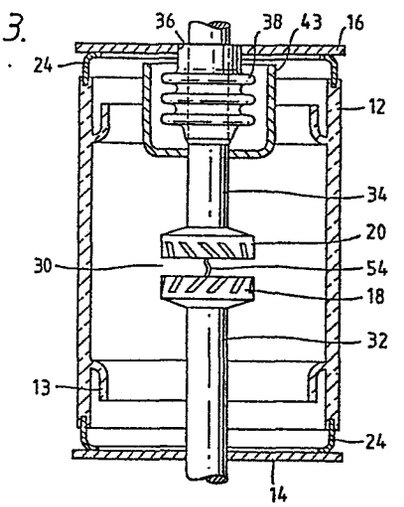
(54) Vacuum devices.

(57) A vacuum device (10) having separable contacts or spaced electrodes (18, 20) in a mainly insulating envelope (12) wherein only a short length of the insulating wall is shielded from metal vapour produced by arcing (54) between the contacts or electrodes (18, 20). The invention relies on the fact that the insulation strength in a vacuum is greater than in air.

Fig.3.



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Vacuum Devices

This invention relates to vacuum devices of the kind that have two separable contacts or spaced electrodes in an evacuated chamber formed by an envelope which is mainly of electrically insulating material for insulating the connections to one contact from those to the other. More particularly, the invention relates to vacuum switch devices such as vacuum interrupters, contactors or loadbreak switches, but is also applicable to other vacuum devices as will be apparent from the following description.

In vacuum switch devices of the kind described above the opening or closure of the contacts under load-breaking or connecting conditions results in the formation of an arc between them, and the inner surface of the insulating wall of the envelope has always been substantially fully shielded from the metal vapour produced by the arc so that the metal would not be deposited on the insulator and so impair its performance. The insulating walls of devices with fixed electrodes capable of arcing in a vacuum, such as triggered vacuum gaps, have similarly been fully shielded.

We have now found, however, that it is possible to allow most of the insulator to be coated in metal, only protecting a small part so as to give

adequate insulation. This is because the insulation strength in vacuum is much greater than that in air.

Accordingly, the invention provides a vacuum device of the kind described above wherein only a minor fraction of the length of the inner surface of the insulating wall of the envelope is shielded from the metal vapour produced on arcing. The shielded region must, of course, form a continuous shielded area completely encircling the inner surface of the envelope but it has been found that insulation of the connections to the contacts or electrodes, as the case may be, from each other can be maintained even when the shielded length of the envelope is quite small.

The minimum length required to maintain the insulation will depend upon the particular device, and the voltages likely to be encountered in use, but may readily be found by trial.

A shield may be in the form of an annulus extending into the envelope for a short distance from the or each end, and may be in the form of a metal cylinder attached to a metal plate closing the respective end of the envelope, the cylinder being located closely adjacent the inner surface of the envelope.

Alternatively a shield may be formed by an annular protuberance on the inner surface of the insulating wall.

In another embodiment of the invention a shield may consist of a ring, either of metal or electrically insulating material, extending inwards from the inner surface of the insulating wall; the ring may be formed as a separate member fixed to the wall or, if of insulating material, may be formed integrally with the wall.

In yet a further embodiment of the invention at least one end of the insulating wall of

the envelope projects into a cylindrical end member closed at its outer end, the end member being sealed to the outer surface of the insulating wall at a region spaced from the end thereof, and the projecting end part of the insulating wall being spaced from the end member. The outer surface of the end part of the insulating wall is thereby shielded from metal vapour produced on arcing.

The invention will now be more fully described, by way of example, as applied to a vacuum interrupter with reference to the drawings of which:-

Figure 1 shows in partial cross-section a conventional vacuum interrupter; and

Figures 2 to 5 show different ways of utilising the present invention in vacuum interrupters of the general kind shown in Figure 1.

Figure 1 shows a vacuum circuit interrupter 10 and comprises a highly evacuated tubular envelope 12 formed from glass or ceramic material and a pair of metallic end caps 14 and 16 closing off the ends of the insulating envelope 12. Seal means 24 are provided between the end caps 14 and 16 and the insulating envelope to render the inside of the insulating envelope 12 to be under vacuum. The pressure within the insulating envelope 12 under normal conditions is lower than 10^{-4} torr to insure that the mean free path for electron travel will be longer than the potential breakdown path within the insulating envelope 12. Located within the insulated envelope 12 are a pair of relatively movable contacts 18 and 20. When the contacts 18 and 20 are separated, there is formed an arcing gap 30 therebetween. The lower contact 18 is a stationary contact secured to a conducting rod 32 by connecting means such as welding or brazing. The conducting rod 32 is rigidly joined to the stationary end cap 14. The upper contact 20 is a movable contact and is joined to a conductive operating

rod 34. The operating rod 34 is mounted for movement along the longitudinal axis of the insulating envelope 12. The operating rod 34 projects through an opening 36 in bellows end cap 16. A metal bellows 38 is secured in sealing relationship at its respective opposite ends to the operating rods 34 and to the bellows end cap 36. Flexible metallic bellows 38 provides a seal around the operating rod 34 to allow for movement of operating rod 34 without impairing the vacuum within the insulating envelope 12.

Coupled to the end of the operating rod 34 is an actuating means (not shown) provided for driving the movable contact 20 into engagement with the stationary contact 18 so as to close the interrupter 10. The actuating means is also capable of returning the movable contact 20 to the open circuit position during circuit interruption.

When the contacts 18 and 20 are separated during circuit interruption, an arc 54 is formed in the arcing gap 30 between contacts 18 and 20. The arc 54, which is formed between the contacts 18 and 20 vaporizes some of the contact material. These vapours and particles are dispersed from the arcing gap 30 towards the insulating envelope 12. The internal insulating surfaces of the insulating envelope 12 are protected from the condensation of the arc generated metallic vapours and particles thereon by means of a tubular main metallic arc shield 40. Main arc shield 40 is supported on the insulating envelope 12 and electrically isolated from end caps 14 and 16, but may be supported from or electrically connected to either end cap 14 or 16, if desired. The shield 40 acts to intercept and to condense arc generated metallic vapours and particles before they can reach the insulating envelope 12. To further reduce the chances for vapours or particles reaching the insulating envelope 12, by bypassing the shield 40, end cap

shields 42 and 44 are provided surrounding the ends of the main arc shield 40. A cup-shaped shield 43 is attached to the movable operating rod 34 and partially surrounds the flexible metallic bellows 38 to prevent the bellows 38 from being bombarded by arc generated metallic vapours and particles.

All identical parts are referenced by the same numeral in the drawings and all the parts, apart from the shields 40, 42, 44 are the same in Figures 2 to 5 as those described above with reference to Figure 1 and will thus not be described again.

In accordance with the invention, therefore, the insulating envelope 12 only needs to be shielded over a small part of its surface provided that this shielded part extends right around the envelope. This can be achieved in many different ways of which only four are illustrated.

Thus in Figure 2, the main shield 40 is removed and only end cap shields 42 and 44 remain. In fact only one of these is strictly speaking required for the insulating envelope 12 to still work properly.

In Figure 3 all the shields 40, 42, 44 are removed and the insulating envelope 12 has an annular projection 13 integral with it. The projection 13 curves over so as to be parallel with the envelope 12 and extends along for a short length so as to shield the envelope at this point from the metallic vapours and thus provide a shielded band extending around the envelope. Once again, although two of these projections 13 are shown, it may be desirable to only provide one of them.

It will be appreciated that although these projections are described as being integral with the envelope in the sense that the envelope is moulded with them in place, they may be attached to the envelope at a later stage and may be either non-metallic such as ceramic or may even be metallic.

Alternatively, the envelope may be moulded with a recess extending into the envelope from one end, the inner wall of the envelope then shielding the inside of the recess and thus providing the shielded band around the envelope.

In a third embodiment of a vacuum interrupter according to the invention, illustrated in Figure 4, the envelope 12 is slightly recessed so as to provide a shoulder 15 against which an annular ring 17 is fixed so as to shield the part of the envelope directly behind the ring in relation to the arc.

The ring 17 may be either metallic or insulating, and in a modification may be simply an annular projection, of similar shape, integral with the envelope and extending inwards from the envelope wall.

In the fourth embodiment of a vacuum interrupter according to the invention, the outer surface of the insulating envelope 12 is formed with a pair of annular steps 19 spaced from the respective ends of the envelope, and the metallic end caps 14, 16, are brazed to metal cylinders 21 which surround, and are spaced from, the thinner end parts 23 of the envelope extending beyond the steps 19. The inner ends of the cylinders 21 are sealed to the steps 19 to close the ends of the envelope 12, and it will be seen that the outer surfaces of the end parts 23 of the envelope effectively provide annular shielded bands.

Thus, in all cases, there is a small area of the surface of the envelope 12, extending right around the envelope, which is shielded from the metal vapours generated by the arc, so that even if the rest of the envelope has metal deposited on it, this band will remain insulating.

However the invention is not restricted to the configurations described, and is also

applicable to other forms of vacuum devices, such as triggered vacuum gaps, having an evacuated insulating envelope in which arcing takes place.

CLAIMS

1. A vacuum device of the kind described above wherein only a minor fraction of the length of the inner surface of the insulating wall of the envelope is shielded from the metal vapour produced on arcing.

2. A vacuum device according to Claim 1 incorporating, for shielding the inner surface of the envelope wall from metal vapour produced on arcing, an annulus extending into the envelope for a short distance from the or each end.

3. A vacuum device according to Claim 2 wherein the shield is in the form of a cylinder located close to the envelope wall and carried by a metal plate closing the end of the envelope.

4. A vacuum device according to Claim 1 incorporating, for shielding the inner surface of the envelope wall from metal vapour produced on arcing, an annular protuberance on the inner surface of the insulating wall of the envelope.

5. A vacuum device according to Claim 1 incorporating, for shielding the inner surface of the envelope wall from metal vapour produced on arcing, consists of a ring projecting inwards from the inner surface of the insulating wall of the envelope.

6. A vacuum device according to Claim 5 wherein the ring is a separate member of metallic or electrically insulating material fixed to the envelope wall.

7. A vacuum device according to any one of Claims 2 to 6 having a pair of shields located one at each end of the envelope.

8. A vacuum device according to Claim 1 wherein at least one end of the insulating wall of the envelope projects into a cylindrical end member closed at its outer end, the end member being sealed to the outer surface of the insulating wall at a region spaced

from the end thereof, and the projecting end part of the insulating wall being spaced from the end member.

9. A vacuum device substantially as shown in and as hereinbefore described with reference to any one of Figures 2 to 5 of the accompanying drawings.

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Fig.1.

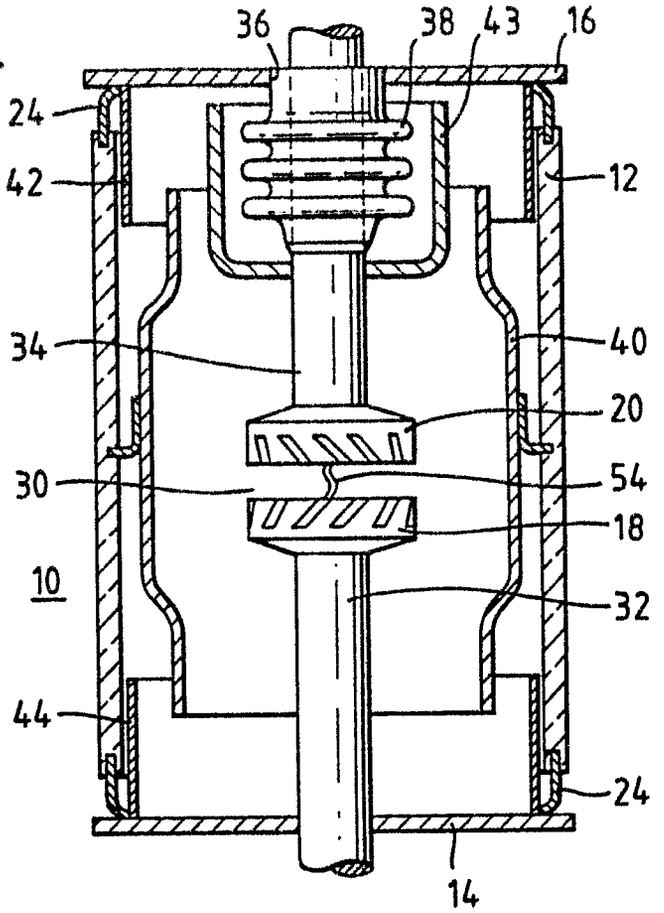

Fig.2.

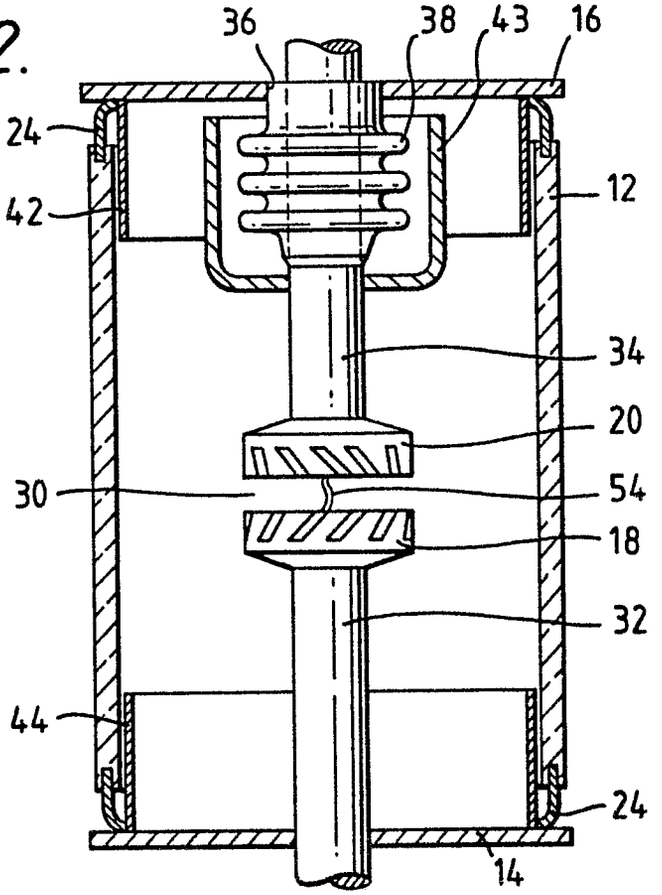

Fig.3.

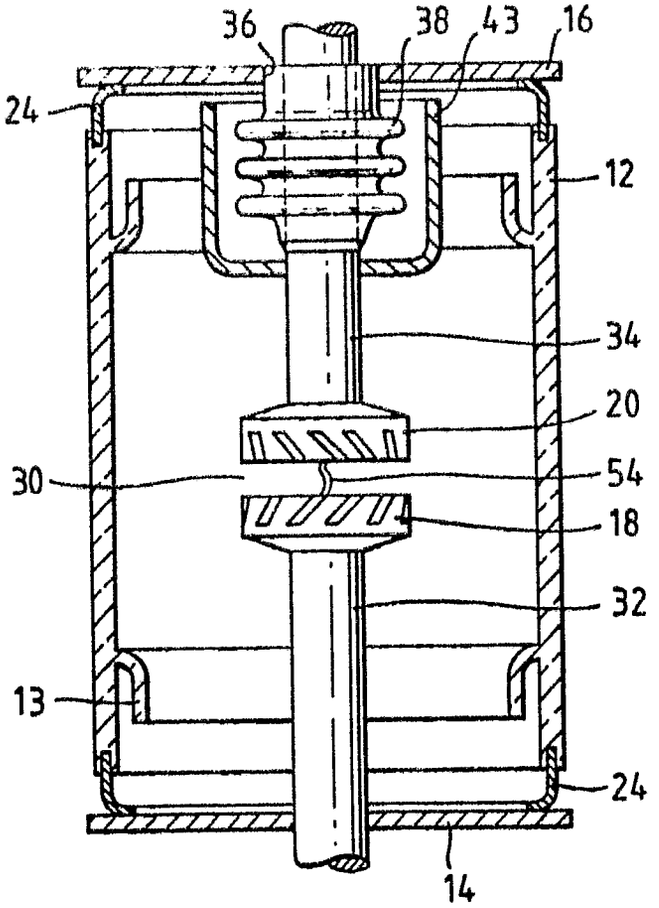
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Fig.4.

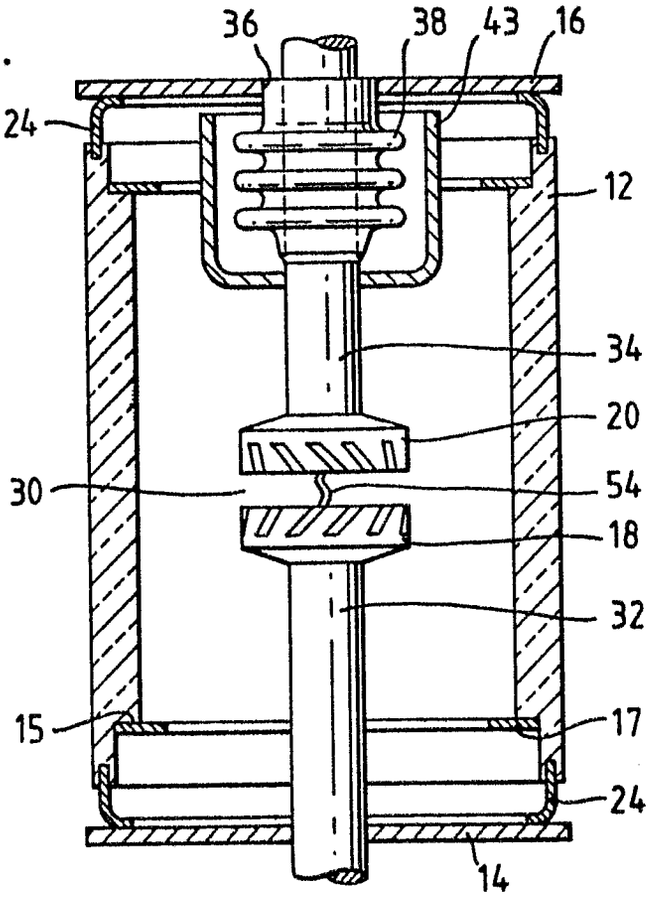
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Fig.5.