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HIGH VELOCITY ARC INTERRUPTER

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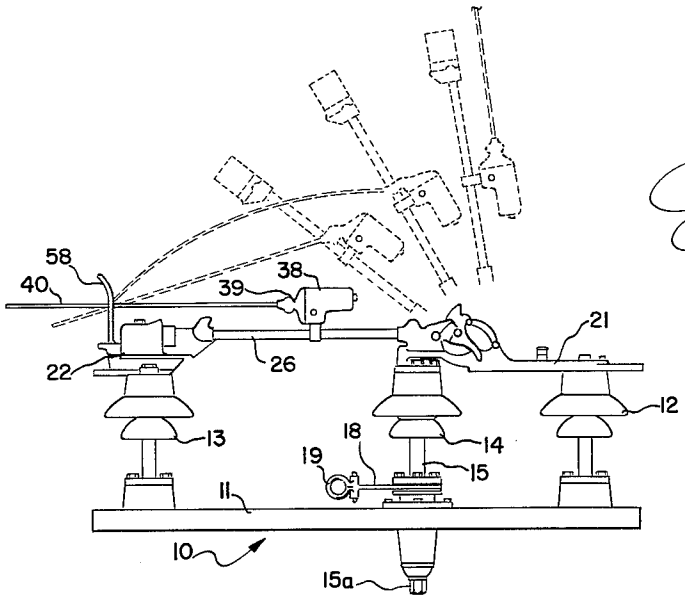

Fig. 1

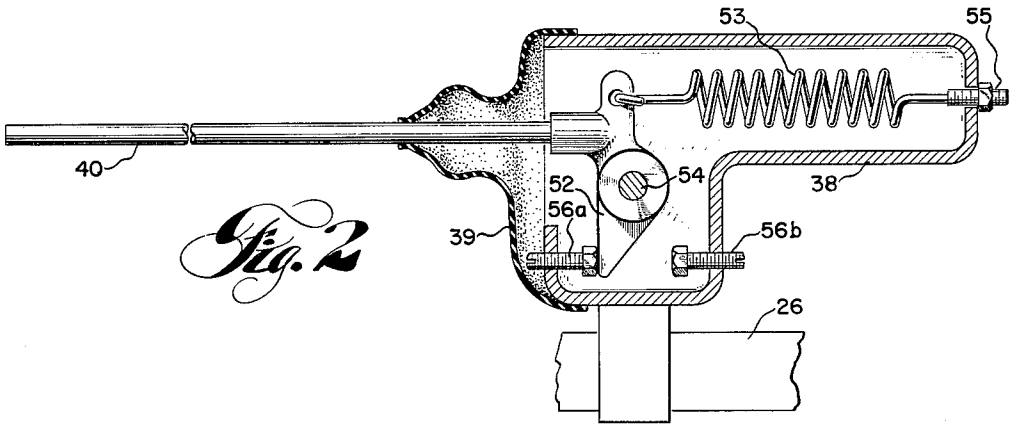

Fig. 2

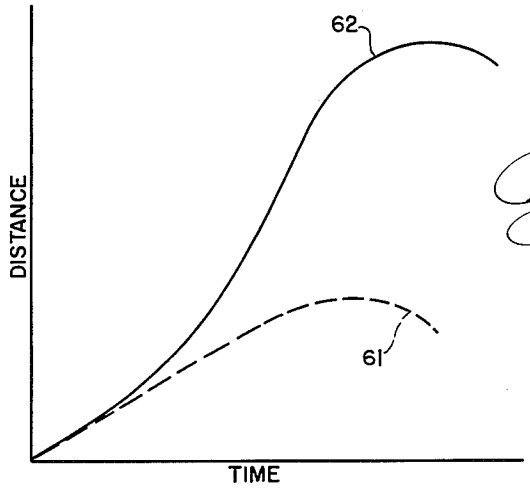

Fig. 3

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HIGH VELOCITY ARC INTERRUPTER

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This invention relates to high voltage arc break disconnect switches and more particularly to switch auxiliary means for minimizing arcs drawn in air when interrupting high voltage circuits.

The switching of high voltage circuits in air presents serious problems, one of which is the tendency to draw long electric arcs which could cause line to ground or line to line faults, thereby causing customer outages. The problem of minimizing arcs drawn in air is one of providing a build up of dielectric strength faster than the rise of recovery voltage across the interrupter, and of being certain that after interruption this dielectric strength is maintained in order to prevent restriking.

In the past, various types of devices have been proposed to minimize arcs drawn in air. One such device is described in Patent No. 2,849,578 issued on an application filed by L. C. Hart and assigned to the assignee of the present invention. The Hart device incorporates a flexible resilient rod which is engageable by a latching device to hold it with respect to stationary contact structure. The resilient rod is mounted parallel to a high voltage disconnect switch and is affixed and connected to the movable switch arm on one end. When the switch is opened, the resilient rod maintains a temporary by-pass of the main switch contacts. After the switch has opened a predetermined amount the resilient rod, which had been flexed to store energy, is released. It then moves with high velocity away from the stationary structure to interrupt the circuit. While the Hart device has operated very satisfactorily for many applications it has required a "strong," shock absorbing, non-oscillatory (non-restriking), hence costly, construction, and sometimes its interrupting capability has not been ideal.

A major factor contributing to the successful interruption of a circuit using this type of arc break device is the speed at which the tip of the interrupter moves away from the previously drawn arc after a current zero. If the buildup of dielectric strength due to the combination of air dielectric between the interrupter tip and the previous drawn arc plus the deionization of the previous drawn arc is greater than the rise in recovery voltage across the switch, the circuit will be successfully opened. If not, the arc will reignite until the next change for interruption at the next current zero.

It is an object of the present invention to provide inexpensive means for overcoming the above mentioned difficulties.

Another object of the invention is to provide an improved, low cost, light weight arc break switch useful for interrupting line charging current, transformer magnetizing current, or small load currents.

Other objects and advantages will become apparent and the invention may be better understood from consideration of the following description taken in connection with the accompanying drawing in which:

FIG. 1 is an elevation view of a high voltage air break switch embodying the present invention and showing several different positions of the switch during operation;

FIG. 2 is an enlarged sectional view of a portion of the switch of FIG. 1, and

FIG. 3 is a graph in which separation distance is plotted against time both for the prior art and for the present invention.

Referring first to FIG. 1, a switch indicated generally at **10** might be any form of high voltage air break switch. As illustrated, the switch **10** comprises a base member **11** formed as of channel iron to provide a rigid support for the switching contacts and operating means. A pair of insulators **12** and **13** are fixedly mounted in spaced relationship on the base **11**. There is also provided a movable insulator **14** positioned between the fixed insulators **12** and **13**. The insulator **14** includes a downwardly extending shaft **15** which is adapted for rotation in a suitable bearing mounted on the base **11**. As illustrated, the end of the shaft **15** disposed on the opposite side of the base **11** from the insulator **14** is provided with a hexagonal end **15***a* which may be engaged by a suitable manual operating lever or the like to cause rotation of the insulator **14**.

For the purpose of operating the switch **10** as a multipole switch, one or more crank arms **18** may be provided to rotate with the insulator and shaft **15**. As illustrated, the crank arm **18** is provided with an operating eye **19** which may be connected to suitable rods interrelating the plurality of poles of the multipole switch to insure simultaneous operation of all poles thereof.

In order to support electrical conductors which together with the switch **10** comprise the circuit to be controlled, there is mounted on the insulator **12** a hinged base and terminal support **21**. On the other hand, there is mounted on the insulator **13** a contact support and stationary contact structure **22**. It will be understood that the supports **21** and **22** are suitably fastened to their associated insulators **12** and **13** in a conventional manner. Many details of the "lower" or main switch structure as shown in FIG. 1 and which includes a movable switch arm or blade **26** form no part of the present invention and, if need be, can be fully understood by reference to the above mentioned Patent 2,849,578.

In accordance with the illustrated embodiment of the present invention a mechanism housing **38** with a weather shielding cover **39** is associated with a resilient, whiplike member **40** as hereafter more fully explained.

As seen in FIG. 2, within housing **38** and cover **39** is a crank **52**, a tension spring **53**, a pivot bearing **54**, a spring adjuster **55**, and two adjustable stops **56***a* and **56***b*. Attached to one arm of the crank **52** is the whiplike resilient rod **40** preferably tapered similar to the rod described in the Patent 2,849,578. The housing **38** and its associate parts are mechanically affixed and electrically connected to the movable switch arm **26**.

During opening operation, the interrupter maintains a temporary by-pass of the main switch contacts **26–22** through a hook or latch **58** on the stationary contact structure **26**. At a predetermined point the spring loaded interrupter rod **40** releases. It then moves away from the stationary contact with a high velocity to open the circuit.

Referring to FIG. 3, in which the abscissas represent time after release of rod **40** from latch **58** and in which the ordinates represent distance between most relevant parts of rod **40** and latch **58**, a curve **61** represents the relationship according to the prior art as exemplified in the previously mentioned Hart patent while curve **62** shows the improved relationship of distance with respect to time when the improvement of the present invention is included with all non sequitur conditions exactly the same as before. One important aspect of the improved relationship has to do with speed (of contact separation) which, of course, may be expressed as dD/dT, and other very important aspects include length of time over which maximal, or near maximal, speed occurs, as well as when maximal

speed (and the length of time it prevails) occurs during the opening cycle. For example, if maximum speed lasts but a short time or occurs only at the very beginning or at the very end of the opening cycle (as according to some prior art other than Hart) it is of little help in preventing damage due to arcing. Several types of arc break devices which suffer such defects each use an arc blade member which is non-flexible in the direction of principal movement. The disadvantages caused by the use of a non-flexible member as the auxiliary interrupter are such that they impose serious limitations on the practicality of the device for more difficult tasks. Because such a non-flexible member rotates about a pivot axis with constant (e.g., separate spring-caused) acceleration the maximum velocity of the interrupter is not reached until the end of its travel thereby causing longer arcs to be drawn. Further, the non-flexible device requires a strong shock absorber to limit the impact of the non-resilient member, and requires extra parts to position such member in a neutral position before the interrupter can be used, both requirements making the interrupter more costly.

Also known in the past is a construction using a non-flexible auxiliary interrupter rod having a flexible tip added for increasing beginning separation speed, but I have found that such an arrangement is actually a hindrance to the efficacy of the auxiliary interrupter, since it *subtracts* from the energy previously stored in the auxiliary interrupter and thus it decreases maximum velocity attained, while it also shifts any new maximum velocity towards the very beginning of opening cycle (where it does little good).

With the present invention, however, the auxiliary blade is itself flexible, resilient, and whiplike, and the flexibility enhances (rather than subtracting from) its speed of movement at the most critical time.

During operation, with the present invention, when the disconnect switch starts to open, the resilient rod **40** is caught in the latch **58** on the stationary contact structure **22**. The first motion that takes place is a rotation of the resilient rod **40** and crank **52** about the pivot bearing **54** inside the mechanism housing **38**, storing energy in the spring **53**, attached to the crank **52**, as the resilient rod **40** and crank **52** continue to rotate until the crank **52** hits the preset stop **56***b*. At that time further rotation of the crank **52** is prohibited, and the spring **53** is fully charged. As the main switch continues to open the resilient rod **40** is bent in a cantilever fashion storing energy in the rod **40**. Continued motion of the disconnect switch causes the resilient rod **40** to release from the latch **58** at a predetermined point (when the spring **53** and the resilient rod **40** are both fully charged), and then the rod **40** will move away from the latch **58** with a very high velocity due both to the tendency of the rod to unflex and to the force of spring **53** acting in such direction as to move **40** away from **58**.

Thus, the storage of energy into the interrupter as caused by the main operating mechanism is broken into two sections: (1) storage of energy into the spring loaded crank **52**, and (2) storage of energy into the resilient rod **40**. By breaking the work performed in opening the switch into two intervals, each extending over a relatively great distance of operation, the maximum operating force is reduced, thereby not requiring as strong or costly switch operating mechanism as did mechanisms heretofore.

Additionally, as seen from comparing the curves of FIG. 3, the maximum dD/dT velocity of the tip of the whip rod has been greatly improver, providing a greater air dielectric to aid interruption, the total motion of the tip has been more than doubled, allowing, if need be, a greater amount of arc deionization, while the time length of maximum dD/dT, and its orientation with respect to total opening cycle, are both optimum.

It should be noted that a part of the advantage of the present invention is due to the fact that the pivot point (of

crank **52** and hence of rod **40**) is moving (e.g., with respect to **58**) with movement of main blade **26**.

There is thus provided a device of the character described capable of meeting the objects above referred to. The higher velocity obtained through the combination of crank **52** and resilient rod **40** motions insures better interrupting capabilities, while the greater distance of motion of the rod due to the combination of crank **52** and rod **40** motions insures better interrupting capabilities. Furthermore, the greater distance of motion of the interrupter due to the combination of crank **52** and rod **40** motions insures that the device may be used without a costly shock absorber to stop the moving arm, and the damping of the device of the invention need only be the naturally inherent friction and windage losses thereby lowering the cost of the interrupter unit. All prior devices for similar purposes have used some form of shock absorber to lessen impact or oscillation of the auxiliary interrupter arm to prevent a restrike or failure of the interrupter and damage to other parts. However, because of the greater distance the interrupter rod travels according to the present invention and because of its having maximum velocity for a longer distance, the oscillation of the rod **40** causes no problem, the air dielectric between the interrupter and the stationary contact being great enough to prevent a restrike.

While I have illustrated and described a particular embodiment, various modifications may obviously be made without departing from the true spirit and scope of the invention which I intend to have defined only by the appended claims taken with all reasonable equivalents.

I claim:

1. In a high voltage switch:

a flexible rod contact and a catch member engaging said rod for a substantial time during switch opening initiation sequence whereby to delay separation of a pair of contacts formed by the flexible rod and the catch,

first means including a spring for storing contact opening energy without substantially flexing said rod for one period during switch opening initiation sequence, and

second means for storing contact opening energy by flexing said rod for another period during the switch opening initiation sequence, said second means including a stop (*56b*) limiting the action of said first means during said last mentioned period.

2. In a high voltage switch of the type having a stationary main contact means and a cooperating relatively movable main contact means and electrically connected in parallel therewith a pair of arc interrupting contact members,

the combination wherein one of said last mentioned members is a resilient whiplike rod contact, having a near end associated with the movable one of the main contact means, and the other of said members is a catch which is fixed with respect to the stationary one of the main contact means and wherein said catch holds the other end of said whiplike rod contact in electrical engagement during a substantial portion of the switch opening operation,

a pivotal crank means for moving said whiplike rod by (a) movement about said pivot and (b) movement of said pivot, and

a stop means for the crank means.

3. A high voltage switch as in claim **2** further characterized by there being a housing substantially surrounding the crank means, and a spring having one end secured to said housing and having an opposite end secured to the crank means to bias the same about its pivot in such direction as to increase velocity and distance of separation of the flexible rod from the catch.

4. The combination of claim **3** further characterized by means, including a predetermined selection of resilience of rod with respect to resilience of the spring which is addi-

tional to said rod, for causing the additional spring to operate first (during opening) and the rod due to its resilience to bow substantially its entire length thereafter (during opening) whereby to obtain a large useful output (as regards distance and speed of separation) with minimal peak input effort (for opening and for closing), and whereby to reduce length of any arc, and obviate the possibility of restrike, and eliminate the need for any shock absorber (for opening).

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