March 22, 1932. T. E. MURRAY, JR 1,850,213

FUSE MECHANISM

Filed Aug. 4, 1928

Fig. 1.

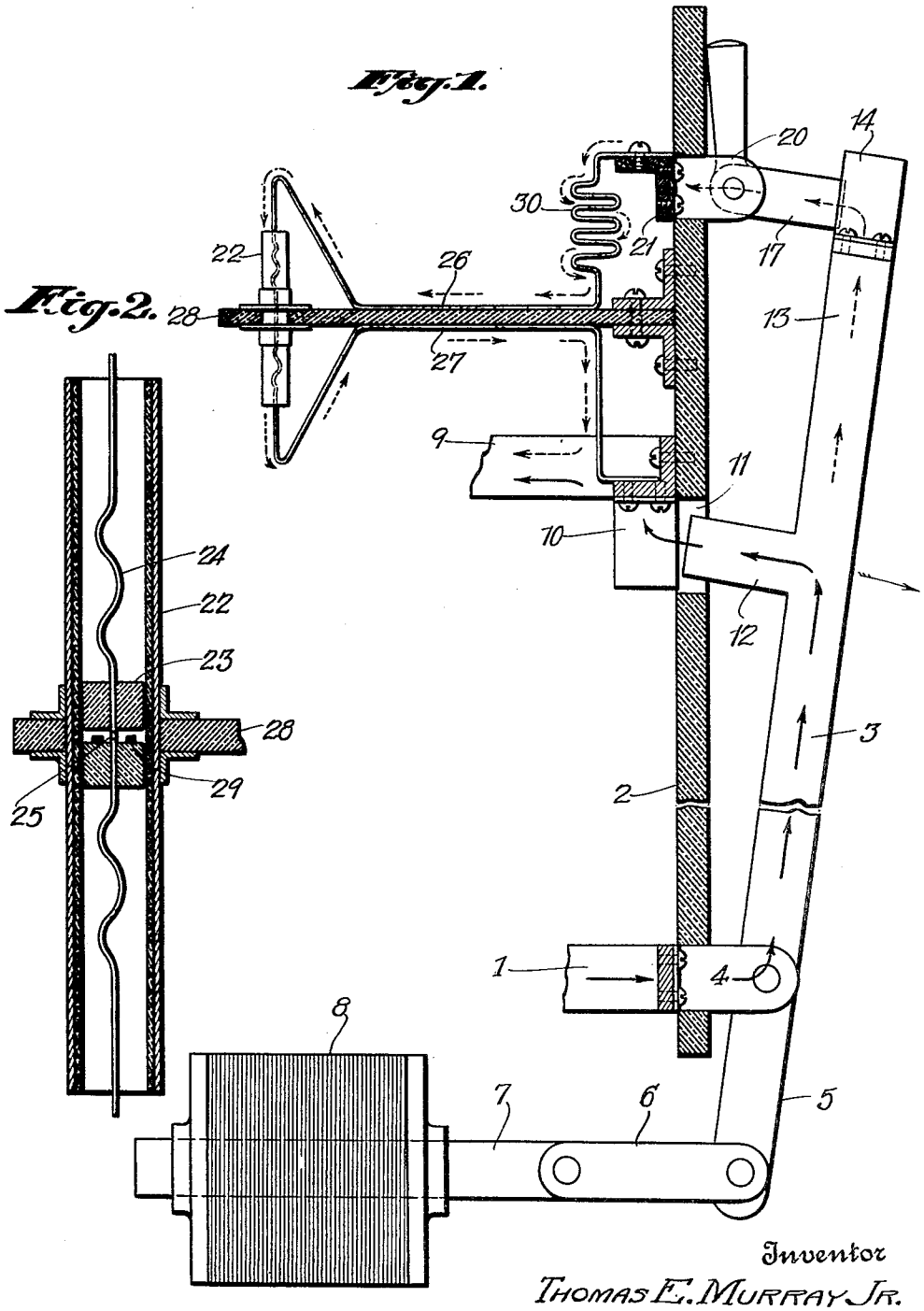


Fig. 2.

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UNITED STATES PATENT OFFICE

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FUSE MECHANISM

Application filed August 4, 1928. Serial No. 297,527.

In my pending application for patent No. 257,861 filed February 29, 1928, I have disclosed an electric circuit carrying a switch and in addition a fuse which will carry the current during the opening of the switch and will break the circuit thereafter, using for this purpose a particular type of fuse covered in certain prior applications.

The present invention provides certain improvements in such circuits and fuses.

The accompanying drawings illustrate an embodiment of the invention.

Fig. 1 is a side elevation, partly in section, of the invention applied to a knife switch;

Fig. 2 is a vertical section of one of the fuses.

Referring to Fig. 1, the incoming bus bar 1 of the circuit is mounted on the barrier or other support 2. On the opposite side of the barrier is a switch blade 3 pivoted on a support 4 which is connected through the barrier to the bus 1. The switch blade may be actuated by means of an arm 5 connected by an insulated link 6 with the core 7 of a quick-acting solenoid 8.

The outgoing bus 9 also mounted on the rear of the barrier carries fixed blade 10 in line with the opening 11 in the barrier registering with the lateral projection 12 on the switch blade. Normally the projection 12 engages the contact 10 and the normal current flows from one to the other bus bar through the switch blade in the manner indicated by the full line arrows.

The switch blade 3 has an extension 13 carrying a set of end contacts 14 adapted to engage respectively contacts 17. These are separate contacts each of which is separately mounted on a bracket 20 supported from an insulating bracket 21. Between the bus bar 9 and the several brackets 20 there are inserted a number of fuses corresponding to the number of switch blades 17 (which may be any desired number).

The fuses are preferably of a type covered in certain prior applications of Murray; for example Serial No. 252,439 filed February 7, 1928.

Fig. 2 shows one of the fuses in section. An open ended tubular case 22 carries a pair of plungers 23 of insulating material adapted to slide freely in the case. The fuse strip 24 has a blowing point 25 located between the plungers at points adjacent thereto. The fuse strip is imbedded and fastened in the plungers. The gas generated by the blowing of the fuse is, therefore, confined and the plungers with their engaged portions of the fuse strip are blown quickly away from the blowing point and out of the open ends of the casing or to such a distance that the circuit cannot be re-established by the passage of the current through the gas generated.

The material and dimensions of the fuse strip and the spacing between the plungers are so calculated that the portion of the strip between the plungers will, on gasification, be sufficient to give the desired quick and wide separation of the plungers with their ends of the fuse strip. The amount of the fusible metal which will be fused or gasified when the blow out occurs is determined by the spacing between the plungers, and is limited by the plungers. The plungers embed the fuse strip so closely that the arc cannot penetrate to a substantial extent, so that the spacing of the plungers determines the quantity of metal which will be gasified.

The leads 26 and 27 to and from the fuse strip are located on opposite sides of a horizontal barrier 28 projecting outward from the back of the main barrier 2. By this arrangement we have a repulsion effect between the two conductors 26 and 27 on the opposite sides of the insulating barrier, which also tends to throw the ends of the fuse strip apart when the reduced portion thereof burns through. The single barrier 28 is used for the entire group of fuses, the casings of the latter being fixed in the outer end of the barrier.

Now when it is desired to break the circuit under a load between the busses 1 and 9, the switch blade 3 is swung outward. When the contact 12 leaves the contact 10, the main connection between the two busses is broken. But there is still a path for the current as indicated by the dotted line arrows through the extension 13 of the switch blade and the contacts 14 and 17 and through the fuse to the outgoing bus 9.

Fig. 1 shows this, which is an intermediate position of the parts. The outgoing movement of the switch blade will be continued beyond the position shown. But when this position occurs the flow of the full current through the fuse blows the latter and completely breaks the circuit between the busses. The further movement of the switch blade carries the contact 14 clear of contact 17.

Two or more fuses may be used in parallel, but ordinarily one fuse in the circuit will serve the desired purpose. When it is blown a new fuse may be substituted by the use of any ordinary fuse replacement device.

The fuse thus serves as a protection for an instant during which the switch is being opened. The current having a path through the fuse at this instant there is no arcing across the main switch contacts and no burning or pitting of the latter.

When the switch is opened and the fuse blows, the plungers or pistons are separated rapidly. But for a time the electrical circuit is carried between them by the metallic vapor produced by the blowing. It is important to open the circuit as quickly as possible.

I have found that this can be done by cutting the size of the tube and plungers to very small proportions. In fact, I have used a fuse having a tube 2½ inches long and ⅜ths of an inch in diameter with a combustion chamber (the space between the plungers) of .027 to .497 cubic inches and such a fuse has operated satisfactorily under short circuit conditions on 2500 volts, 60 cycles, using 100 amperes. It opened the circuit in less than ¼ of a cycle. This represents a time of less than 1/240th of a second, a speed previously unheard of in electrical practice.

The intensity of a short circuit is proportioned to the length of time taken to open or break it. As the time is lengthened, the short is liable to build up enormous values. For example, a 100 ampere fuse on 240 volts might draw a load from the main line or generator of 100 times its normal capacity, that is 10,000 amperes. Its efficiency depends on the speed with which it can clear the circuit.

In the effort to find the smallest fuses available for practical dimensions of the fuse ribbons, I have determined that the length of the tube should be at least about eight times its internal diameter. For example, a ½ inch tube for 2600 volts should be four to five inches long, for 6,600 volts, six to eight inches and for 11,000 volts, twelve to fourteen inches. If the inside diameter is changed, the length should be changed in proportion. If the above fuses have a diameter of one inch, their lengths should be double the above figures. These figures are approximate. But they represent fairly the best proportions available with the ordinary fuse ribbons to secure the quickest complete clearing of a circuit.

Other metals than the ordinary fuse metal, which is approximately a composition of solder, would make it possible to reduce still further the size of the fuse and the quickness of its operation. Silver, for example, having a higher electrical conductivity, would permit the use of a small cross-section compared with the ordinary fuse metal for the same high amperage capacity.

Additional means may be used to accelerate the rate of expansion, such as the introduction of a small quantity of gun cotton or other explosive in the combustion chamber which would ignite and explode immediately. In Fig. 2, for example, small pieces 29 of gun cotton are fixed on the top of the lower plunger.

I propose to use, therefore, an extremely small fuse on high tension lines carrying normally a number of amperes greatly in excess of the capacity of the fuse, the latter being of the minimum size which will carry the current long enough to permit the complete withdrawal of the switch contacts without arcing.

I propose also to provide a certain resistance, indicated at 30, Fig. 1, in the line of the fuse so as to retard the flow of the full current through this line and to prevent the blowing of the fuse until the switch contacts are completely separated; that is separated to such a distance that there is no danger of an arc across them when the fuse circuit is broken. This resistance should be enough to overcome the E. M. F. drop across the main contacts. I have used in such circuits the following fuse capacities.

Current in main circuit	Size of fuse.
500 to 1000 amperes	25 ampere fuse
200 to 500 amperes	20 ampere fuse
100 to 200 amperes	15 ampere fuse
75 to 100 amperes	10 ampere fuse
25 to 75 amperes	5 ampere fuse

A resistance of ten ohms in the fuse circuit has given very good results. This allows about one ampere or less to flow through the fuse circuit during regular operating conditions.

No claim is made herein to the fuse separately, the same being claimed in my application No. 320,795, filed November 21, 1928.

Various modifications in detail may be made by those skilled in the art without departing from the invention as defined in the following claims.

1. An electric circuit-breaker comprising a switch, a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions.

2. An electric circuit-breaker comprising a switch, a casing, a fusible element therein, a plunger on said fusible element adjacent its blowing point confining the gas generated by blowing the fuse and causing it to expel the plunger, said fusible element adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter, and means for preventing excessive current through the fusible element under normal operating conditions.

3. An electric circuit-breaker comprising a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter, said fuse being of the minimum size which will carry the current long enough to permit the complete withdrawal of the switch contacts without arcing, and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions.

4. An electric circuit-breaker comprising a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter, said fuse comprising a casing, a fusible element therein, a plunger on said fusible element adjacent to its blowing point confining the gas generated by blowing the fuse and causing it to expel the plunger, said fuse being of the minimum size which will carry the current long enough to permit the complete withdrawal of the switch contacts without arcing, and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions.

5. An electric circuit-breaker comprising a switch, a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions, said resistance being sufficient to retard the flow of the full current through the fuse and to prevent the blowing thereof until the switch contacts are completely separated.

6. An electric circuit-breaker comprising a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter, said fuse being of the minimum size which will carry the current long enough to permit the complete withdrawal of the switch contacts without arcing, and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions, said resistance being sufficient to retard the flow of the full current through the fuse until the switch contacts are completely separated.

7. An electric circuit-breaker comprising a fuse adapted to carry a portion of the current under normal operating conditions and during the opening of the switch and to break the circuit thereafter, said fuse comprising a casing, a fusible element therein, a plunger on said fusible element adjacent to its blowing point confining the gas generated by blowing the fuse and causing it to expel the plunger, said fuse being of the minimum size which will carry the current long enough to permit the complete withdrawal of the switch contacts without arcing, and a resistance in line with the fuse to prevent excessive current through it under normal operating conditions, said resistance being sufficient to retard the flow of the full current through the fuse until the switch contacts are completely separated.

In witness whereof, I have hereunto signed my name.

THOMAS E. MURRAY, JR.