

July 19, 1949.

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2,476,842

CONTACT PROTECTIVE NETWORK

Filed April 3, 1945

FIG. 1

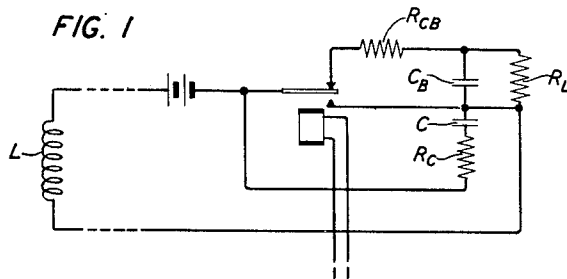


FIG. 2

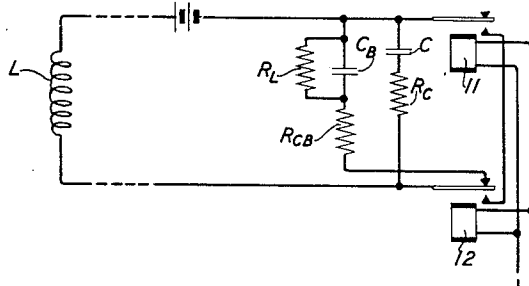
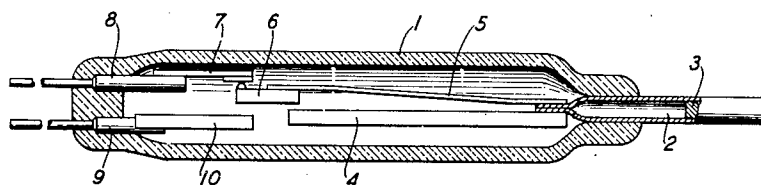


FIG. 3



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2,476,842

CONTACT PROTECTIVE NETWORK

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Application April 3, 1945, Serial No. 586,375

3 Claims. (Cl. 175-294)

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This invention relates to circuit makers and breakers and particularly to contact protection systems.

The object of the invention is to provide protection for the contacts of a remotely controlled switching means against the destructive effects produced by extraordinary circuit operations. In certain situations where weight is a great consideration it has been found convenient to employ glass sealed contact making devices controlled from a central point for operating remotely situated electrical devices such as small motors. An available contact maker has been found to be adequate and reliable for all ordinary service but liable to quick destruction under extraordinary conditions as where the motor fails to operate properly and the contacts are called upon to repeatedly open and close the motor circuit and thus to handle the starting current which may be very greatly in excess of the ordinary operating current. Since it is absolutely essential that contact failure must be avoided under even such extraordinary conditions contact protection must be provided to care for even the rare and unlikely occurrence of these extraordinary conditions.

It has long been known that a condenser in series with a resistance bridged about a contact used for breaking a current flow is an effective means for "killing" a spark or an arc produced by such action. However, as the current to be broken becomes greater the amount of capacity necessary to be used also becomes greater with the adverse result that with a greater amount of energy stored the conditions on the closing of the contacts become more intolerable. Heretofore where fast breaking contacts as on an ordinary relay where the armature can have developed considerable speed before the contacts controlled thereby are actually moved apart, the problem of contact protection was not so acute and conditions could be tolerated which would be extremely undesirable in the type of contact used herein where the armature itself carries the contact breaking surface and whose initial movement is, therefore, correspondingly slower. It has been discovered that contacts will not arc if the voltage between them is held below a certain value for a certain time, but since this time is measured in microseconds the comparatively slow movement of the contacts of the glass enclosed devices is a limiting factor. While these devices are capable of breaking the normal current, they are subject to deterioration where through chattering or other reasons they may be called upon

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to break the heavy current caused by the discharge of the contact protecting condenser or the heavy starting current of the motor.

The invention consists of an auxiliary back contact and an auxiliary condenser and resistance for diverting the transient caused on the opening of a circuit and to limit the duration of air arc if formed to a harmless period.

A feature of the invention is the use of a back contact making device to protect a front contact thereof. In accordance with this feature a back contact which performs no other function in the circuit is employed to connect into circuit an electrical network which will provide a path for energy released through the opening of the circuit through the front contact thereof.

Another feature of the invention is a condenser-resistance contact protecting network having a discharge path normally connected about the said condenser and capable of discharging the said condenser in a minimum period.

The drawing consists of a single sheet having three figures as follows:

Fig. 1 is a schematic circuit diagram showing a single relay with a back and front contact provided with a contact protection network forming the basis of the present invention;

Fig. 2 is a similar schematic circuit diagram showing an arrangement which may be used when a circuit is closed through two contacts in series; and

Fig. 3 is a sectional view of a typical glass sealed contact element.

The contact element of Fig. 3 consists of a glass envelope 1 into one end of which a tube 2 is sealed. This tube is at first used for tubulation purposes, that is, for exhausting the envelope of air and for later filling it with an inert gas and is later sealed by filling the outer end with solder 3. Within the tube the element 2, which becomes a terminal of the device, has a magnetic element 4 welded to it as well as a spring 5 carrying a magnetic armature 6. The spring 5 is flexed so as to normally hold the armature 6 with its contact against a non-magnetic element 7 welded to terminal 8. Another terminal 9 also sealed into the opposite end of the tube has a magnetic element 10 welded thereto. As shown, there are air-gaps between elements 4, 6 and 10 so that if this contact device is inserted in a coil and thus affected magnetically, the armature 6 will be drawn to bridge the gap between the two elements 4 and 10 and thus to extend an electrical connection from the terminal 2 to the

terminal 9 breaking a normal electrical connection between the terminal 2 and the terminal 8.

Glass sealed contact devices of this nature are in common use and have proved highly satisfactory in service, particularly in remote control devices. There are instances where it is desired to use such small and light-weight elements (Fig. 3 is greatly enlarged) to control loads which have a high starting current characteristic. The contact established between the elements 6 and 10 is capable of carrying the normal current but would be liable to destruction if it were called upon to break a current of greater intensity.

When relay contacts are used to break a direct current at voltages exceeding about 20 volts, it is commonly observed that the contacts do not arc visibly at very low currents, but as the current interrupted is increased, arcing appears and the duration of the arcs increases as the current is further increased. Eventually a current is reached at which the arc continues until the power is removed or the contacts are destroyed. Observations on contacts which are protected by a capacitor and resistance shunt which is inadequate to prevent arcing also show that, considerably before the current value which sustains an arc indefinitely is reached, the arc persists for several milliseconds after the contacts have reached their maximum separation and extinguishes itself at a voltage little, if any, higher than that which sustained it previously. This is of interest in showing that, if the contacts form a "transfer" with a "make" and a "break" contact, the latter might be used to modify the current conditions and extinguish the arc long before it would cease otherwise.

This may be taken advantage of in certain cases where a relay is ordinarily called on to interrupt a current which is strong enough to cause a harmful arc if the contacts are unprotected, but which normally is within the range which permits the use of capacitor and resistance "arc suppressor." Assume, for instance, a direct current motor whose normal full load current is 4 amperes. With protection consisting of a suitable condenser, for example, 10 microfarads, in series with 2.5 ohms, contacts carrying this current may be expected to open the circuit without arcing. If the motor is overloaded so that the current to be broken is six amperes, the contacts will commence to arc, and at 8A the arcing might be prolonged and destroy the contacts in a single operation.

An attempt to increase the protection so that arcing would not occur at 8A would require reducing R_c to 1.25ω and increasing C to 20 or more microfarads. This would greatly increase the welding effect of the discharge of the protection through the contacts on closing or chattering, and might very well cause the contacts to stick. In any case the heavier protection would much increase the contact erosion under normal operating conditions, although it would be useful only under unusual overloads.

In such a situation the protection shown in Fig. 1 may be useful and economical. A pair of contacts is protected for normal loads by C in series with R_c which hold the initial voltage between the opening contacts below the minimal arc voltage (here taken as 15 volts) long enough to prevent an arc from forming when the contacts are opened on their normal current. An additional suppressor, C_b in series with R_{cb} is connected between the usual "make" contact and an added "break" or back contact, so as to be in cir-

cuit only when the "tongue" or "swinger" contact is at rest on the "break" contact. C_b is provided with a resistance shunt R_L , low enough to discharge it during the time the relay is expected to be held closed to operate the motor. A resistance of ten or more thousand ohms would ordinarily be adequate. Where very rapid opening and closing of the relay is expected a tungsten filament lamp will give a quicker discharge than a constant resistance.

The operation is as follows: When the relay is open both C and C_b are charged to battery voltage, and a small leak current flows through R_L . When the relay closes, C discharges through the "swinger" and "make" contacts and R_c , while C_b discharges much more slowly through R_L . When the relay opens the normal current there is no arc, the voltage between the contacts rises instantaneously to 10 volts, then starts more slowly towards a value controlled by the load, and by C. When the "swinger" reaches the "break" contact, this voltage rise is checked by the addition of $C_b + R_{cb}$ to the circuit and the voltage then starts from a lower value to rise to a new peak controlled by $C + C_b$. If $C = C_b$ and is large enough so that the surge does not rise to a value higher than that of the battery while the "swinger" is traveling from the "make" to the "break" contacts, and if $R_c = R_{cb}$ the charging current of C_b when the "swinger" touches the "break" contact, and the resulting erosion will be no greater than those when the "swinger" touches the "make" contact.

When the motor here represented by the load L is heavily overloaded or stalled, and the relay opened, C + R_c no longer hold the initial voltage between the "swinger" and "make" contacts below the critical value, and an arc forms and persists. When the "swinger" touches the "break" contact the connection of the uncharged condenser C_b across the arc, diverts momentarily a large part of the current through C_b and R_{cb} , dropping the arc voltage below that necessary to sustain it. The arc is extinguished and will not restrike, as the distance between electrodes is now too large.

This method of operation limits the duration of an arc due to abnormal loading of the contacts to the travel time of the "swinger" from "make" to "break" contacts, which in suitable relay structures, may be considerably less than 1 millisecond. The same improvement is not to be gained simply by adding C_b to C. This would permit only a small increase in the current before arcing occurred while increasing the erosion on contact closing by doubling the energy dissipated at the first contacting areas.

The advantage of this method may be gained with a relay structure having two contacts in series if it is provided with a back contact, as is common in the design of power relays. In this case the connections are as in Fig. 2. Here two relays are shown in conventional form with both windings 11 and 12 connected in parallel and their contacts in series so that upon energization the load L will be connected in series with the source of current through the armature and front contact of relay 11 and the front contact and armature of relay 12. In this case the armature of relay 12 is provided with a back contact controlling the networks R_L , C_b and R_{cb} while the ordinary suppressors C and R_c are connected in such a way as to protect the contacts of both relays upon opening.

What is claimed is:

1. A network for protecting a pair of circuit

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breaking contacts consisting of a conventional capacity and resistance circuit bridged about the said contacts, a second capacity and resistance circuit, a condenser discharge path bridged about the said capacity of said second circuit and means for bridging said second circuit about the first said circuit when the said contacts are moved apart.

2. In a circuit closing device, a pair of magnetically operated circuit closers each operated by an electromagnet, the said electromagnets being connected in multiple to operate simultaneously, said circuit closers being connected in series, a conventional capacity and resistance circuit bridged across said circuit closers to dissipate sparks on the opening of said contacts, a back contact on one of said circuit closers and a network consisting of a resistance and having a condenser bridged about a portion of said resistance and connected between said back contact and the other of said circuit closers to shunt said first resistance and condenser circuit to dissipate the charge of said first condenser.

3. In a circuit maker and breaker, a contact protective network consisting of a primary conventional condenser and resistance circuit bridged about said circuit maker and breaker, a secondary

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condenser and resistance circuit having a leak resistance bridged about said secondary condenser, and means operative upon the opening of said circuit maker and breaker for bridging said secondary circuit about said primary circuit to provide additional capacity to protect said circuit maker and breaker on the opening thereof and to discharge said primary condenser during the open period thereof to protect said circuit maker and breaker on the closer thereof.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,419,872	McLain	June 13, 1922
2,011,395	Cain	Aug. 13, 1935
2,172,677	Hathaway	Sept. 12, 1939
2,221,136	Harms	Nov. 12, 1940
2,292,174	Suits et al.	Aug. 4, 1942

FOREIGN PATENTS

Number	Country	Date
477,113	Great Britain	Dec. 22, 1937