

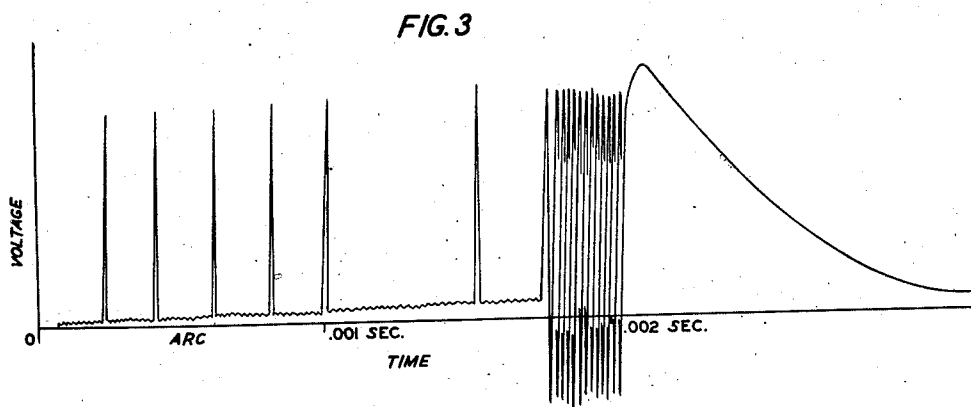
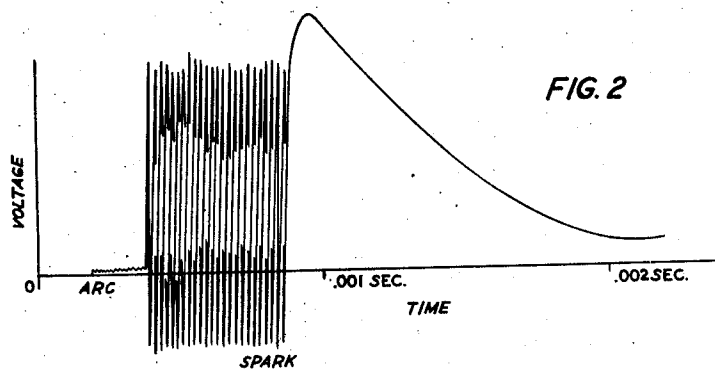
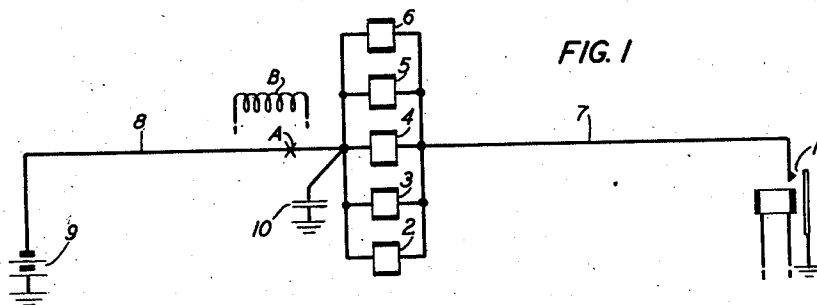
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CONTACT PROTECTION DEVICE

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CONTACT PROTECTION DEVICE

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This invention relates to contact-protecting devices and has for its object the provision of means whereby the relatively movable contacts through which the current of an inductive load flows may be relieved of injurious burning or arcing when the usual protective networks may not be applied to such contacts.

In circuits involving contacts which make and break an inductive current, it is customary practice to protect the contacts from deterioration due to arcing and sparking by bridging said contacts with a protective network that usually comprises a condenser of suitable capacity and a resistance in series therewith to limit the charge and discharge of the current through the condenser when the contacts make and break the circuit.

It is also well known that, when a set of contacts breaks an inductive circuit, the energy stored in the inductive portions of the circuit is dissipated in heat accompanying a spark across the contacts. However, before the inductive energy begins to dissipate, there may be an antecedent period during which, although the contacts are separated, the current is not interrupted but only reduced somewhat, the conducting path being a column of vaporized metal. This is known as the arcing period, and if the current is much above the arcing limit of the metal of which the contacts are composed, the duration of the arc will be sufficiently prolonged to cause a rapid disintegration of the contacts. The duration of the arc is influenced by the contact material and that intensity of the current which will produce disintegration, is, of course, different with different materials. Under these circumstances, it is entirely possible that a pair of contacts may be designed which, if the current they are to break is below the arcing limit of the material of which the contacts are composed, will have a life that will be satisfactory without any contact protection. In cases where the current broken is beyond the arcing limit of the contact material, contact protection is, of course, desirable.

It very often happens, in electrical circuits, that while the current which has to be broken by a pair of contacts is beyond the arcing limit of the contact metal, a network to protect them will interfere with the operation of the circuit, especially where the load comprises relay networks the time of operation or release of one or more of the individual relays in which might be interfered with by the charge or discharge of the protective network, in which event pro-

tective networks may not be used around the contacts.

My invention is primarily directed to affording relief in circuits of this kind; that is, in circuits where the contacts have to break a current which is somewhat beyond the arcing limit of the metal of which the contacts are composed and yet, because it is desirable not to interfere with the time constants of the various elements of the load circuit, no protective network may be applied to the contacts themselves or to the load.

My invention is illustrated in the accompanying drawing, in which:

Fig. 1 is a conventional diagrammatic showing of an ordinary relay circuit controlled through a pair of contacts;

Fig. 2 is an approximate graphical representation of the voltage between a pair of contacts opening a circuit such as that of Fig. 1, as it would appear on a cathode ray oscilloscope of proper characteristics, an arc lasting a small fraction of a millisecond being ruptured and followed by a spark discharge of the energy stored in the inductance of the load relays. This shows a condition in which the short duration of the arc would permit a reasonable life of the relay contacts; and,

Fig. 3 is a graphical representation of an extension of the arc under conditions which my invention is intended to remedy by causing the discharge to revert to that of Fig. 2.

Referring to Fig. 1, there is shown a pair of contacts 1 which are connected to a load circuit comprising a plurality of electromagnetic devices 2, 3, 4, 5, 6, etc., a source of current 9 connected to the load relays over a conductor 8 and thence through the contacts 1 over conductor 7, and a condenser 10 connected to ground at the junction between the load relays and the battery supply conductor 8.

It has been found that, in the absence of condenser 10, the duration of the arc at the load contacts 1 is not only a function of the current and of the metal of which the contacts are composed, but also of certain critical electric constants of the conductor which connects the load with the source of current. For example, experiments have determined that the length of conductor 8 is an important factor in the duration of the arc and it has been further determined that if this conductor 8 is shorter than a certain critical value, say six feet for a conductor having a capacity of 100 millimicrofarads, the arc will be normal for the metal of the con-

tacts which, when they open, will dissipate the inductive energy in the usual way. This is graphically represented in Fig. 2 which shows the presence of a brief arcing period after the contacts are separated, after which the arc breaks and the inductive energy is dissipated by the sparking which follows. The duration of the arc, while variable, is a function of the material of the contacts, while the length of the sparking depends partly upon the quantity of stored energy that has to be dissipated. However, as conductor 8 is increased in length, which is to say, as the electrical capacity from the source of current to the load is increased, the duration of the arc is also increased or, more accurately, the first rupture of the arc is followed by an oscillation of conductors 7 and 8 which by-passes the load relays through the shunt capacity inherent in their windings and causes very brief surges which contain sufficient energy to reestablish the arc each time it is ruptured. The number of times which this phenomenon occurs is, to a certain degree, a function of the length of conductor 8. Fig. 3 illustrates graphically what happens when conductor 8 is considerably longer than a certain critical value which, as said before, for a conductor of specific constants, is six feet. The duration of the arcing condition shown in Fig. 3 is sufficient to cause rapid destruction of the contacts.

In circuits of the kind illustrated in Fig. 1, the load contacts 1 may be protected by bridging a condenser and resistance thereacross to which the condenser 10 is of no assistance as the arc and spark accompanied by high frequency transients are prevented at their source. However, if the relays of the load circuit, namely, relays 2, 3, 4, 5, etc., have functions which depend upon the critical release and operate times following the opening or closure of contacts 1, it is obvious that such operate and release times will be interfered with by the charging and discharging of the protective circuit.

In my invention, the arcing of the contacts may be reduced to normal limits by bridging a low impedance condenser 10 across the junction between the line to the battery and the windings of the load relays for those cases in which the battery conductor 8 is beyond the critical length. In such cases the condenser 10, the radio frequency impedance of which should be of the order of 100 ohms or lower, will prevent the transfer of the high frequency energy between conductor 8 and conductor 7 and, in this manner, prevents the reestablishment of the arc after the first rupture. This reduction in the duration of the arc from the condition indicated in Fig. 3 to that indicated in Fig. 2 gives a considerable improvement in the life of the contacts and does not increase the operate and release times of the load relays 2, 3, 4, 5, 6, etc.

A suitable radio frequency choke coil B of low distributed capacity may be serially connected between conductor 8 and the windings of the load relays at A of Fig. 1 either alone by interrupting the conductor at A and connecting the coil B therebetween or with the condenser 10 and will, by itself or in cooperation with condenser 10, eliminate the effects due to the radio frequency oscillations of conductor 8, but the desired effect may be produced more economically and conveniently by condenser 10 alone.

What is claimed is:

1. Means for reducing the arcing between a pair of contacts that make and break an electrical current load of a value not greatly above the arcing limits of the material of which the contacts are composed, which comprises a condenser one side of which is connected to the battery supply conductor at the junction thereof with the load and the other side to the other battery supply conductor.

2. In an electric inductive circuit, a pair of contacts for making and breaking said circuit, a source of current the terminals of which are connected to said circuit by conductors having a capacity of the order of 100 millimicrofarads and over, and a condenser connected across said conductors at the terminals where they connect with said circuit.

3. An electric circuit comprising magnetic storage devices, a pair of contacts one of which is connected to one side of said storage devices, a source of potential one terminal of which is connected to the other of said contacts and the other to the other side of said storage devices by a conductor longer than a predetermined length, and a condenser connected to said conductor where it joins said storage devices and to that one of said contacts which is connected to said source of potential, whereby the arcing at said contacts when opened to break the circuit is reduced to normal limits.

4. An electric circuit comprising magnetic storage devices, a pair of contacts comprising a metallic substance having an arcing limit below the current required to operate said magnet devices, a source of potential, one of said contacts being connected to one side of said storage devices and the other of said contacts being connected to one terminal of said source of potential, a conductor for connecting the other terminal of said source of potential to the other side of said storage devices, said conductor having a length to produce an arc of abnormal duration between said contacts when they open said circuit, and a condenser bridged between said conductor where it joins said storage devices and said other battery terminal, said condenser having a value sufficient to reduce the duration of the arc to the normal limits for the material of which said contacts are composed.

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