

Oct. 20, 1931.

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1,827,940

MAGNETICALLY ENGAGED CONTACT MEMBERS FOR ELECTRIC SWITCHES

Filed June 29, 1929

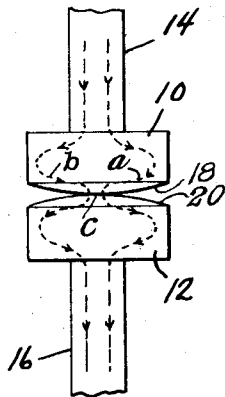


Fig. 1.

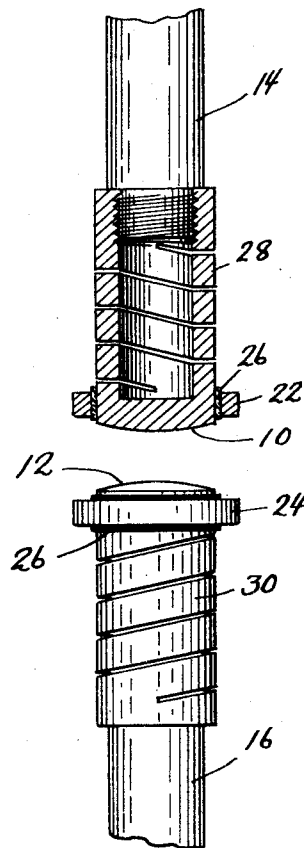


Fig. 2.

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MAGNETICALLY ENGAGED CONTACT MEMBERS FOR ELECTRIC SWITCHES

Application filed June 29, 1929. Serial No. 374,840.

This invention relates to electric switches and circuit interrupters and especially to contact structures therefor particularly adapted for carrying and interrupting large values of alternating current.

When the cooperating separable contact members of an alternating current switch are in engagement and a heavy current traverses them, and particularly when the contact members are solid, the current traversing the contact junction and the adjacent conducting paths of the contact members exerts forces thereupon tending to separate them. This separating force is a fluctuating force and is maximum when the current is maximum and is nil when the current is nil, which is at the time the current is passing through the zero point of the current wave. The contact members may be so disposed with respect to the general conducting circuit through the switch, or especial means may be provided, so that a magnetic reaction is set up which acts to oppose the repulsive effect of the current traversing the contact members. Such counter-acting magnetic means, however, is also fluctuating and follows in intensity the variations of the current traversing the contact members. Thus, the contact members are acted upon by a periodically fluctuating force which varies from zero to a maximum. This is not desirable. While it is true that the magnetic force which acts on the contact members is in opposition to the force which tends to separate them, it is not necessarily true that this opposing force always overcomes the separating force, since the electric characteristics of the circuits which determine the two forces are usually entirely different. Thus, while the opposing force may overcome the separating force at the peak of the current, it may not overcome the separating force for lower values of current. Consequently, arcing will take place between the contact members notwithstanding the presence of the opposing force. Furthermore, the periodical application of forces to the contact members tends to cause them to vibrate and thus, while possibly not actually separating them, at least sets up a periodical

variation of contact pressure which can result in arcing and burning.

It is an object of the present invention to provide electro-magnetic means tending to hold the contact members in engagement at the time the current through the contact members is passing through zero and specifically to arrange such means so that it will be most effective in holding the contact members in engagement at the time the current is passing through zero.

A further object of the invention is the provision of electro-magnetic means which will exert a practically constant force on the contact members, tending to hold them in engagement regardless of the periodical variations in the strength of the current traversing the contact members.

Another object of the invention is the provision of electro-magnetic means acting on the contact members to hold them in engagement, which means varies in effect in accordance with the intensity of current through the switch, combined with other electro-magnetic means which also acts to hold the contact members closed and also varies in effect with variations in intensity of the current but is out of phase therewith so that the resultant of the two forces on the contact members is practically constant.

A yet further object of the invention is the provision of electro-magnetic means to hold the contact members closed, which means is energized by current derived from the current traversing the contact members but is out of phase therewith.

A further object is generally to improve the construction and operation of electric switches and their contact members and to methods for holding the contact members in engagement against the electro-magnetic separating forces of the current traversing them.

Fig. 1 is a diagrammatic representation of a pair of characteristic cooperating separable contact members of an electric switch and illustrating the magnetic reactions therebetween.

Fig. 2 is a side elevation, partly in section, of a pair of cooperating contact members embodying the present invention.

As shown in Fig. 1, the switch may have the two typical cooperating contact members 10 and 12 of which 10 may be the fixed member and 12 the movable member. The contact members are carried by studs 14 and 16 respectively which conduct the current into and out of the contact members. The contact members have the contacting faces 18 and 20 respectively which, as here shown, are spheroidal although they may be of other configuration. Regardless of the shape of the contact members and the configuration of the contact faces of the contact members, the contact junction between them is essentially a point. Due to electro-magnetic forces set up by the current traversing the contact members and the contact junction and to the skin effect of the alternating current, the current paths are divergent in the contact members and are concentrated at the contact junction. Thus, the current paths *a* and *b* tend to follow the configuration of the contact surfaces 18 and 20 into and out of the contact junction *c*. The flow of current in the contact paths of the two contact members is thus in opposite directions. Conductors traversed by currents flowing in opposite directions are repelled by the reaction of the interlinked magnetic fields thereof. Due to the close proximity of the contact faces 18 and 20 and to the concentration of current in and immediately under said contact faces, the repulsive forces acting to separate the two contact members are relatively great.

In that embodiment of the invention shown in Fig. 2, the contact members 10 and 12 are associated with electro-magnetic means which is in series with the current path through the contact members and which tends to urge the contact members into engagement. To this end, the contact members 10 and 12 are connected with and, as here shown, are integral with solenoids 28 and 30 respectively. Said solenoids consist of a plurality of convolutions arranged in single layers, the adjacent ends of the convolutions being connected with the contact members and the remote ends being connected with the studs 14 and 16 respectively. The magnetic fields of the two solenoids are interlinked and are so arranged that the solenoids attract each other thus urging the contact members into engagement and more or less overcoming the above described repulsive action of the contact members. Since the solenoids are in series with the contact members, the contact engaging pressure set up by them is greatest when the current is greatest and is nil when the current is passing through the zero point of the current wave. In accordance with this invention, electro-magnetic means are provided to create a contact engaging force which acts in opposition to the separating force; and furthermore, is most effective at the time the current travers-

ing the contact members is passing through the zero point of the wave. To this end, the contact members 10 and 12 are encircled by close-circuited conducting rings 22 and 24 which rings are carried by and are fixed rigidly to the contact members and are insulated therefrom by the thin layer of insulation 26. Said rings 22 and 24 constitute the close-circuited secondary windings of an air transformer of which the contact members and their associated solenoids constitute the primary winding. Due to the alternating current traversing the contact members, and particularly the solenoids, which sets up flux that threads said rings, an alternating current is caused to circulate through said rings 22 and 24 and, by reason of the inductive or transformer relation between said rings and the contact solenoids, the current in said rings is a maximum at the time the current traversing the contact members and the solenoids is passing through the zero point of the current wave. Since the current in both rings is in the same direction at all times, the magnetic fields of said rings are interlinked in a manner which tends to draw them toward each other. Since the rings are mechanically connected with the contact members, the forces between the rings thus urge the contact members into engagement; and the engaging pressure is greatest when the current traversing the contact members is least, or when the current is passing through the zero point of the wave. Consequently, by the combined effects of the rings and the solenoids, the contact members are maintained electro-magnetically in engagement regardless of the periodical alternations of current. Thus, there is a constant electro-magnetic flux tending to hold the contact members in engagement at all times regardless of the variations of current strength. For this reason, also, the contact engaging pressure is maintained more uniform. By proper proportioning of the solenoids and rings, the contact pressure may be maintained practically uniform at all times. The solenoids 28 and 30 in Fig. 2 constitute the primary windings of the air transformer of which the rings constitute the secondary windings. By reason of the increased magnetic flux set up by the solenoid over that set up by the single conducting path of Fig. 1, an increased induced current is generated in the rings. Thus, the effect of the rings is enhanced over the showing of Fig. 1.

A contact member having one of the transformer rings but adapted for another purpose is described and claimed in my copending application Serial No. 329,431, filed December 31, 1928.

I claim:

1. An alternating current electric switch having a pair of separable contact members and electromagnetic means creating a mag-

netic field at said contact-members urging them into engagement at the time the current traversing said contact members is passing through the zero point of the current wave.

5 2. An alternating current electric switch having separable contact members and electro-magnetic means energized by current derived from the current passing through said contact members having means creating a magnetic field at said contact members and urging them into engagement at the time the current traversing said contact members is passing through the zero point of the current wave.

15 3. An alternating current electric switch having separable contact members and electro-magnetic means having an inductive connection with the current path through the switch having means creating a magnetic field in the arc zone between said contact members and urging them into engagement at the time the current traversing said contact members is passing through the zero point of the current wave.

25 4. An alternating current electric switch having a pair of separable contact members and closed circuit windings inductively related to the current path through the switch having mechanical connections with said contact members and each arranged in the field of the other when the contact members are in engagement and being attracted toward each other whereby to urge said contact members into engagement.

35 5. An alternating current electric switch having separable contact members and closed-circuit windings surrounding said contact members and mechanically connected therewith and arranged one in the magnetic field of the other, said windings being traversed always in the same direction by current induced therein from the current traversing said contact members and being attracted toward each other, whereby to urge said contact members into engagement.

45 6. An alternating current electric switch having separable contact members, and electro-magnetic means including solenoids having interlinked magnetic fields acting uninterruptedly to urge said contact members into engagement while current is traversing them.

50 7. An alternating current electric switch having separable contact members and electro-magnetic means including solenoids having interlinked magnetic fields which act continuously upon said contact members to urge them into engagement while current traverses them regardless of the periodical cessation of the current traversing said contact members.

60 8. An alternating current electric switch having separable contact members and a plurality of electro-magnetic means urging said contact members into engagement, said means having their maximum effectiveness at different times.

9. An alternating current electric switch having separable contact members, solenoids associated with each contact member cooperating to hold said contact members in engagement, and other solenoids associated with each contact member also cooperating to hold said contact members in engagement, said first solenoids being traversed by the current traversing the contact members and said second solenoids being traversed by current inductively induced therein by the current traversing said contact members, whereby the magnetic effects of said first and second solenoids are out of phase with each other.

10. An alternating current electric switch having separable contact members, solenoids carrying said contact members and being traversed by the current which passes through said contact members, the magnetic field of said solenoids being interlinked and said solenoids attracting each other whereby to urge said contact members into engagement, and close-circuited windings carried by said contact members and arranged in the magnetic fields of said solenoids and having their own fields interlinked whereby to urge said contact members into engagement at times said solenoids are ineffective.

In testimony whereof, I have signed my name to this specification.

TALMA T. GREENWOOD.

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