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ELECTRICAL PROTECTIVE SYSTEM

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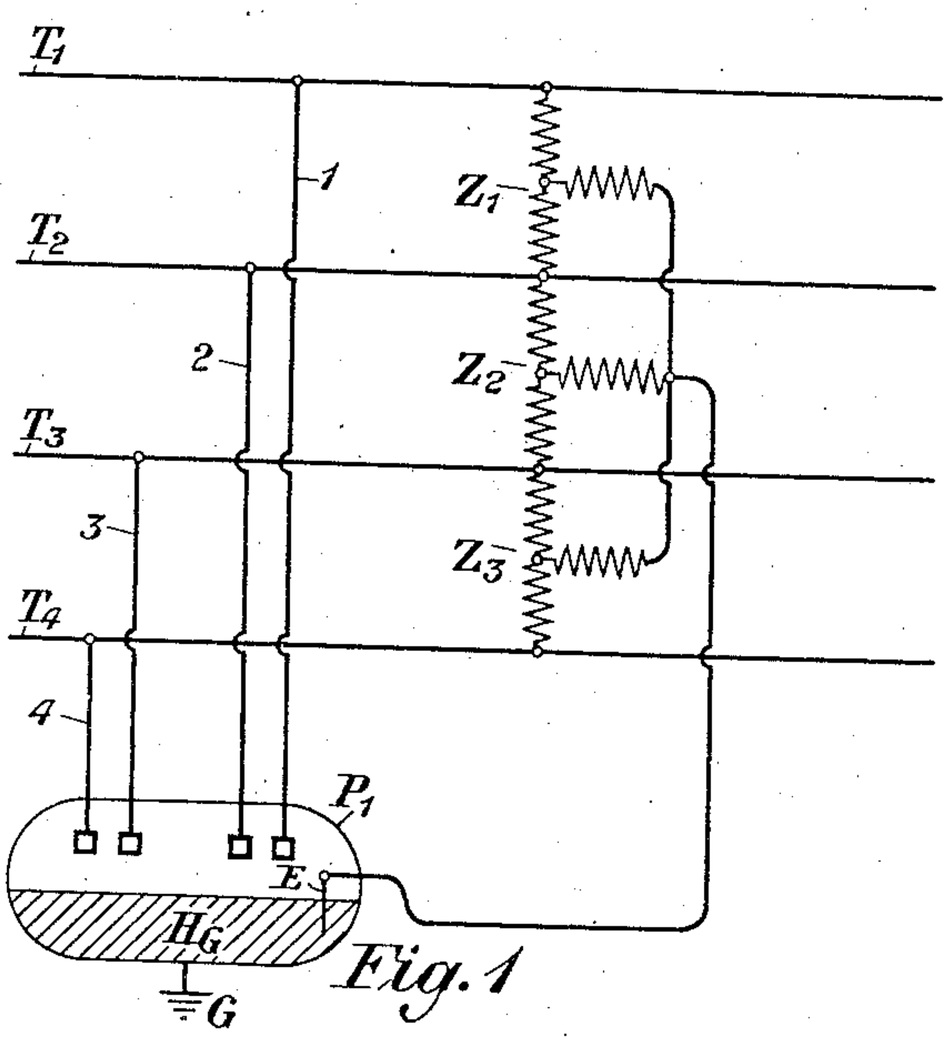

Fig. 1

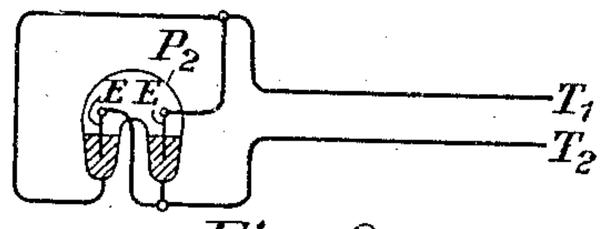

Fig. 2

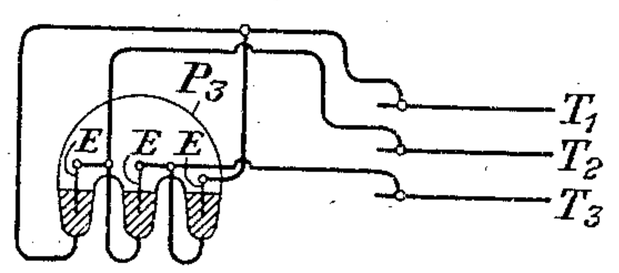

Fig. 3

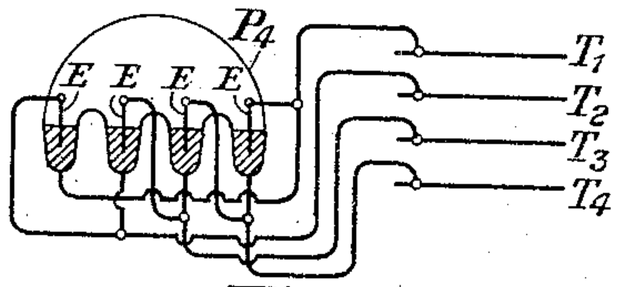

Fig. 4

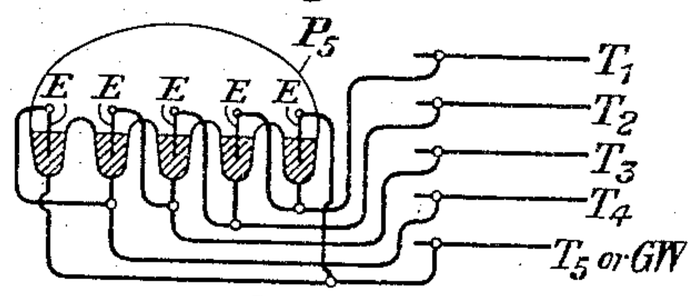

Fig. 5

Fig. 6

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ELECTRICAL PROTECTIVE SYSTEM

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3 Claims. (Cl. 175—294)

This application is a division of application Serial No. 93,910, filed August 1, 1936, now Patent No. 2,103,430, Dec. 28, 1937, and entitled Electrical protective system.

This invention relates to voltage-limiting devices for electrified railways. It further relates to electrical protective systems and more particularly to arrangements for simultaneously connecting in parallel or grounding a plurality of railway tracks when voltages above a predetermined value become impressed on one or another of railway tracks.

In the course of operation of one or more railway tracks there may occur periods of short circuit or excessive load on the electrification system associated with the tracks. At such times the voltage that may exist between the tracks and the ground may be excessive and this invention relates specifically to an arrangement for limiting that voltage. Briefly the limitation of voltage to ground is effected by short-circuiting the rails to each other or to ground for the duration of the disturbance producing the undesired voltage. The limitation of these voltages under abnormal conditions may frequently be desired from the standpoint of electric shock hazard, particularly in the vicinity of passenger station platforms. Such interconnection of tracks and conductors in parallel therewith during abnormal conditions also will be generally advantageous from the standpoint of the reduction of inductive effects produced by the associated currents in the electrification system.

The invention will be better understood by reference to the following specification and the accompanying drawing, in which Figure 1 shows an arrangement applicable to D. C. electrification; Fig. 2 shows an arrangement adapted to either A. C. or D. C. electrification systems, with reference particularly to two tracks; and Figs. 3 to 6 show a similar arrangement applicable to a larger number of tracks.

In the devices shown with the various figures, the same principle is used in all and they differ only in the details of their application. More particularly, use is made of an insulated receptacle containing one or more pools of mercury equipped with igniting electrodes. A short circuit occurring on one of the tracks in the vicinity of the point of connection of the device will produce a difference in potential between that track and ground and between that track and the remaining tracks and conductors, such as ground wires, in parallel therewith. This difference in potential is impressed upon the igniting electrode and after an interval, depending upon the design of the apparatus and the minimum voltage for which operation is desired, ionization of the mercury vapor in the receptacle takes place and the resistance between the main electrodes is rapidly lowered to the extent that current is permitted to flow between them, thus more or less effectively short-circuiting the conductors to which these electrodes are connected. The voltage drop across the established arc will be approximately 15 volts and is substantially independent of the current. After termination of the disturbance producing ignition voltage, ionization ceases in the receptacle and the insulation between the various structures is restored.

Referring more specifically to Fig. 1, T_1, T_2, T_3 and T_4 represent the tracks, each track in general comprising two rails. A mercury vapor device P_1 contains a pool of mercury, which is grounded at G. An igniting electrode E, which is connected to the tracks to be protected through bridged resistances or reactances or similar coupling arrangements Z_1, Z_2 and Z_3, dips into the mercury pool as shown in the figure. This ignition electrode E is preferably of high resistive material such as thyrite, carborundum or other refractory material which possesses some conductivity. In addition each track is connected by conductors 1, 2, 3 and 4 to a separate current-carrying anode in the receptacle, these anodes being preferably symmetrically situated with respect to the mercury pool, which latter serves as a cathode connected to a low resistance ground, or to a ground wire, as shown at G. In the event that a short circuit occurs on any one of the tracks, the voltage on the igniter E is sufficient to produce an initial ionization which immediately fills the tube with ionization and reduces the resistance between the mercury pool and the anodes to such an extent that all of the tracks are immediately short-circuited to ground. This short circuit is maintained as long as the disturbing voltage persists, and upon its cessation deionization in the tube occurs and the tracks are restored to a normal condition.

In view of the characteristics of the mercury tube, it will be evident that this arrangement will be effective only in the event that one of the tracks becomes positive with respect to ground and then only if its potential exceeds that of ground potential by a certain value determined by the design of the mercury vapor device. Also, T_1, T_2, etc. have been spoken of as each being a track with two rails. Actually T_1 may be one rail and T_2 the other rail of a track.

Fig. 2 shows an arrangement for application to either an A. C. or a D. C. system by virtue of an interconnection in the structures involved. Thus P_2 comprises an insulated receptacle containing two mercury pools, each with an igniter electrode. Each pool is connected with one rail of a track and the igniter for that pool is connected to the other rail of the two shown in Fig. 2. Thus the rail T_1 is shown as having a connection to one mercury pool and a connection to the igniter electrode of the other mercury pool. So, also, for rail T_2. In the event of a short circuit to one of the rails or structures to which the device is connected, a difference in potential is set up between that structure and the other. This potential difference, being impressed upon the corresponding igniting electrode, produces ionization of mercury and a consequent breakdown of resistance between the two mercury pools, thus bringing the rails T_1 and T_2 to substantially the same potential. T_1 and T_2 may each represent a track of two rails in which case the rails would be bridged by impedances such as Z_1, etc., of Fig. 1.

The same explanation holds for Figs. 3, 4 and 5 which show respectively protection for 3, 4 and 5 tracks. The protection device consists in each case of an insulating receptacle which contains a mercury pool for each track or other conductor to be protected, and each mercury pool is equipped with an igniting electrode. With this arrangement a short circuit to any one of the tracks or structures initiates ionization in the mercury receptacle which spreads throughout the receptacle, thus short-circuiting all the tracks to each other and connecting them virtually in parallel for the duration of the disturbance. In case there is a ground wire or system of ground wires, and it is desired to short-circuit the tracks to this ground wire during the period of disturbance, then that ground wire or system of ground wires takes the place of one of the tracks as shown in Fig. 5.

The arrangement of Fig. 6 is a refinement applicable to A. C. or D. C. electrification systems and specifically employs a substantial system of ground conductors GW. In this arrangement the receptacle, as in the previous cases, is provided with a mercury pool for each track. Here the two rails of any one track are shown separately and bridged by a suitable impedance such as Z_1, of such character that it does not interfere with normal track signaling. Each track is shown as connected from a midpoint of its bridging impedance to one of the mercury pools. An additional mercury pool is provided for the ground wires. Each of the pools connected to the tracks is provided with an igniting electrode, all of these electrodes being connected to the ground wire. At the same time the pool connected to the ground wire contains a plurality of igniting electrodes, one for each track to be protected, and connected to that track. With this arrangement it is apparent that ignition will occur in the event of excessive potential on any one of the tracks of either a positive or a negative value and, as a result of the initial ionization thus produced, all of the tracks will be short-circuited to the ground wire for the duration of the disturbance.

It has been found, experimentally, that in an electrification system containing a number of tracks and a substantial ground wire system, a short circuit on one track may produce a substantially larger difference in potential between that track and the ground wire system than between that track and any of the other tracks.

In all of the arrangements shown the tracks are permanently interconnected through the igniting electrodes. These electrodes, however, are confined to materials possessing a high initial resistance. Thus no difficulty is presented in designing the apparatus so that it will not interfere with track signals.

While this invention has been described in connection with a limited number of tracks or parallel conductors, it is evident that it may be arranged to accommodate any number of such tracks or conductors and will provide protection against any desired voltage to ground, within reasonable limits.

What is claimed is:

1. In a protective circuit for an electrification system, the combination of a plurality of conductors subject to excessive disturbing voltages, means for short-circuiting these conductors to each other during the period of disturbing voltages, said means comprising an evacuated vessel, a plurality of electrodes in the vessel, one connected to each of the conductors to be protected, a readily vaporizable conducting electrode in said vessel, an igniter electrode of high resistance associated with the said vaporizable electrode and connected through a substantial non-reactive resistor in common with all of the conductors, said igniter electrode being of such character as to initiate ionization in the vessel when the potential on one of the conductors becomes excessive.

2. In a protective circuit for an electrification system, the combination of a plurality of conductors subject to excessive disturbing voltages, means for short-circuiting these conductors to each other during the period of disturbing voltages, said means comprising an evacuated vessel, a plurality of electrodes in the vessel, one connected to each of the conductors to be protected, a mercury pool in said vessel, an igniter electrode of high resistance associated with the pool and connected through a substantial non-reactive resistor in common with all of the conductors, said igniter electrode being of such character as to initiate ionization in the vessel when the potential on one of the conductors becomes excessive.

3. The combination of claim 2 characterized by the fact that the mercury pool is itself part of the ground wire system.

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