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A. B. NOMANN

2,222,953

ELECTRIC CIRCUIT

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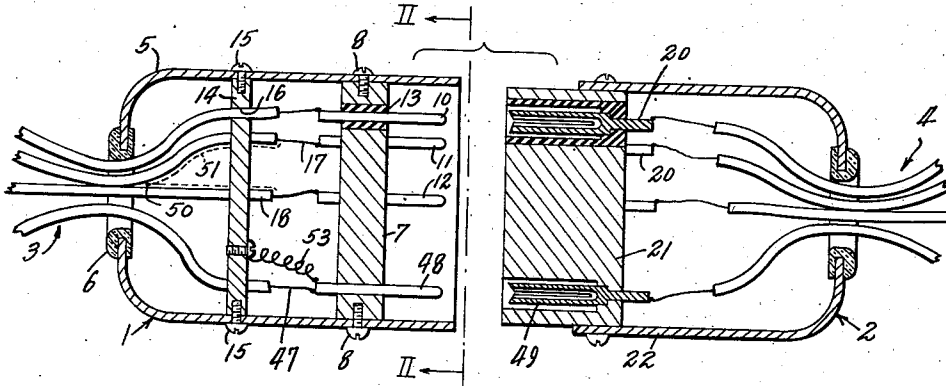


Fig. 1.

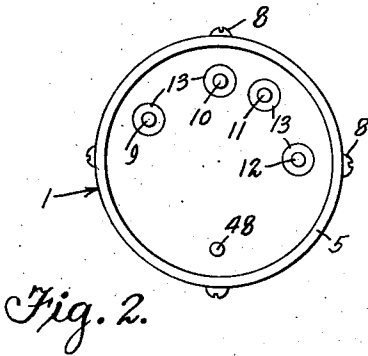


Fig. 2.

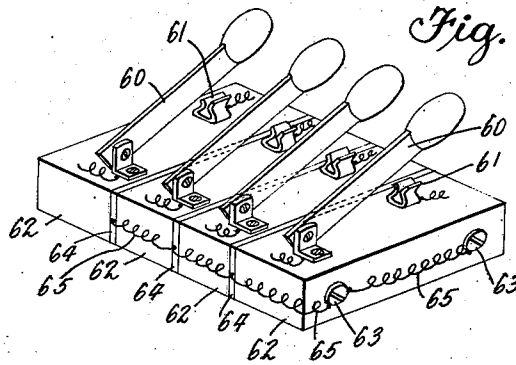


Fig. 3.

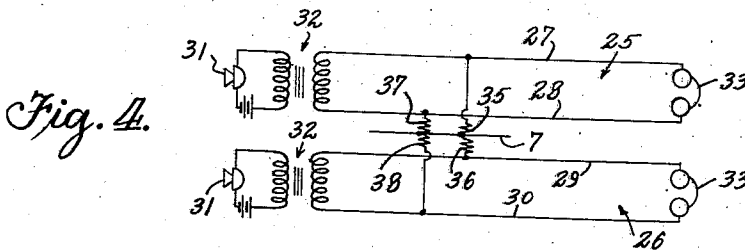


Fig. 4.

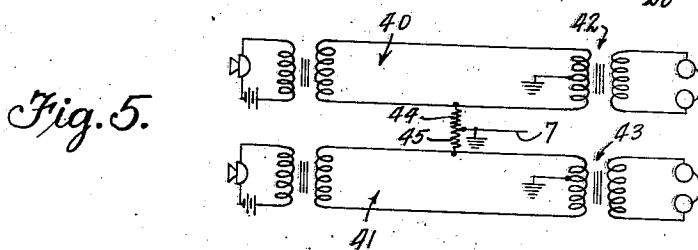


Fig. 5.

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ELECTRIC CIRCUIT

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This invention relates broadly to electrical systems, in which conductors in different circuits are so arranged that unavoidable impairment of the insulation between conductors may produce intercoupling between different circuits, and a broad object of the invention is to prevent such intercoupling from resulting in response to such impairment of the insulation.

The impairment of the insulation referred to frequently occurs when bare portions of the conductors in different circuits are in contact with solid insulating material exposed to moisture. The leakage path is along the surface of the insulating material, wires covered with suitable insulation showing low leakage through the insulation under moist conditions.

A particularly common source of trouble from current leakage in electric signaling apparatus for use in the field, is in multiple connectors employed to complete two or more distinct signaling circuits; the insulating surfaces of such connectors may become coated with dust or mud, which, when wet, has a relatively low resistance.

In accordance with the present invention, I prevent intercoupling of circuits through leakage across the insulation surfaces separating conductors in the different circuits by breaking the insulation leakage paths between conductors with a neutral conducting element, the latter effectively preventing the setting up of leakage current between conductors of different circuits, although it cannot prevent leakage between the conductors of each individual circuit. It is to be understood, however, that in many circuits substantial leakage between the two conductors of a single circuit can be tolerated, whereas leakage between the conductors of different circuits cannot be tolerated.

The invention will now be more clearly explained by describing in detail some particular embodiments of the invention, as disclosed in the drawing, it being understood that these particular embodiments serve as examples only, and that numerous variations from the specific structures shown may be made without departing from the invention.

In the drawing:

Fig. 1 is a longitudinal sectional view through a multiple circuit connecting plug, in accordance with the invention;

Fig. 2 is an end view cross section, taken in the plane II—II of Fig. 1;

Fig. 3 is a perspective view of a multiple blade knife switch in accordance with the invention; and

Figs. 4 and 5 are circuit diagrams illustrating the theory of operation of my invention.

Referring first to Figs. 1 and 2, the plug connector therein disclosed comprises a male member 1 and a female member 2 connected to the ends of wires 3 and 4, respectively, which are to be interconnected by engaging the plug members 1 and 2.

The male plug member 1 comprises a housing or shell 5 which is open at both ends but is preferably constricted at the rear end to define a relatively small opening through which the wires 3 enter. The orifice at the small end may have an insulating bushing 6 therein to protect the wires 3 from mechanical abrasion. Mounted within the shell 5 near the forward end thereof is a metal partition 7 which may be secured in position within the shell 5 by screws 8. This partition 7 has insulatingly supported therein a plurality of contact prongs 9, 10, 11 and 12, respectively, which prongs are connected at their rear ends to different ones of the wires 3. Each of the prongs 9 to 12, inclusive, may be insulatingly supported in the metal partition 7 by an individual bushing 13 of insulating material, which bushings are fitted snugly in apertures provided therefor in the partition 7.

Positioned rearwardly of the partition 7 is a second metal partition 14 which may be similarly mounted within the shell 1 by screws 15. This partition 14 has apertures 16 therein, each dimensioned to pass one of the insulated wires 3. Each of these wires consists of a central metal conductor 17 surrounded by insulating material 18 which may be rubber or other suitable insulating material. The insulation 18 of each of the wires 3 preferably fits snugly within its associated aperture 16 so that the metal plate 14 makes good electrical contact with the exterior surface of the insulation 18.

The female connector member 2 is substantially identical with the male member 1, except that the connector elements 20 are in the form of split sleeves adapted to engage the prongs 9, 10, 11 and 12 when the two members are pressed together. Furthermore, the conductive block or partition 21 which supports the prongs 20, extends beyond the end of the shell 22 of member 2 so that it can enter into the open end of the shell 5 when the members are pressed together.

In the female member 2 as illustrated in Fig. 1, there is no partition corresponding to the partition member 14 of the member 1. It is to be understood, however, that such a partition may be

and is preferably employed in the member 2 as well as in the member 1.

The plug construction disclosed in Figs. 1 and 2 differs fundamentally from prior multiple-circuit connector plugs known to me, in that the connector prongs are insulatingly supported by the bushings 13 in the conductive plates 7 and 21, whereas heretofore the entire partitions or plates corresponding to plates 7 and 21 were made of insulating material.

With the former construction, if the surface of the insulating material between the prongs became coated with dust, mud, water or other conductive material, leakage paths were frequently set up between the prongs connected in different circuits so as to cause objectionable intercoupling between such circuits. If the different circuits were telephone circuits, then the intercoupling resulted in cross-talk, conversations over one circuit being heard on the other circuit. However, such intercoupling is objectionable in many signaling circuits other than telephone circuits, and the invention is in no sense limited to use in telephone circuits, although for convenience in description, telephone circuits will be discussed.

With the construction shown in Fig. 1, intercoupling between the connector prongs connected to different wires as the result of leakage across the surface of the insulation elements 13, is prevented by virtue of the fact that all leakage paths between the different connector prongs are intercepted by the metallic wall 7, the resistance of which is negligible. Hence all leakage paths from all of the connector prongs terminate at a single point of common potential, and no potential difference can be set up in any of the signaling circuits as the result of leakage from one or both conductors of another circuit.

This operation can be more readily explained with reference to the schematic circuit of Figs. 4 and 5. In Fig. 4, two independent telephone circuits 25 and 26 are disclosed, the circuit 25 including a pair of line conductors 27 and 28, respectively, and the circuit 26 including a pair of line conductors 29 and 30, respectively. For simplicity, these telephone circuits are illustrated as one-way circuits, each circuit having a microphone 31 connected thereto at one end through an induction coil or transformer 32 and having a telephone 33 connected to the opposite end.

Let it be assumed now that at some point intermediate their ends the four conductors 27, 28, 29 and 30 pass through a plug connector of the type shown in Figs. 1 and 2, in which for convenience it may be assumed that the line conductor 27 is completed through the prong 9 (Fig. 2); the line conductor 28 through the prong 10; the line conductor 29 through the prong 11; and the line conductor 30 through the prong 12. Assume, further, that the insulating bushings 13 have their exposed surfaces coated with conductive material, such as mud, so that the insulation is imperfect. Thus there may be formed a leakage path represented by the resistances 35 and 36 between conductors 27 and 29 and a second leakage path represented by resistances 37 and 38 between conductors 28 and 30. However, both of these resistance paths are intercepted by the metal partition 7 so that the junction point of resistances 35 and 36 and resistances 37 and 38 are always at the same potential. By virtue of this fact both conductors 27 and 28 of circuit 25 and conductors 29 and 30 of circuit 26 are connected by the unavoidable leakage paths to a point

of common potential and different potentials cannot be applied to the two sides of either circuit by leakage from the other circuit.

On the other hand, it will be readily observable from an inspection of Fig. 4, that if the metallic interconnecting partition 7 were eliminated, a potential could be applied from conductor 28 to conductor 30 through the resistances 37 and 38 and from the conductor 27 to the conductor 29 through resistances 35 and 36, thereby creating a condition of cross-talk.

In the case of two metallic circuits as in Fig. 4, it is necessary to create two leakage paths from two points of different potential in one circuit to two points of different potential in the other circuit. However, in many instances independent circuits are provided with a common ground connection so that it is only necessary to create one leakage path between one point in one circuit and another point in the other circuit in order to intercouple the circuits. Thus in the circuits of Fig. 5, two telephone circuits 40 and 41, respectively, are equipped with transformers 42 and 43, respectively, the midpoints of which are grounded. With such an arrangement, it will be readily observable that a leakage connection represented by two resistances 44 and 45 in series between one side of circuit 40 and one side of circuit 41, will suffice to intercouple the two circuits and produce cross-talk. However, if the junction point of the two resistance paths 44 and 45 is connected to ground, as shown, then this junction point is maintained at the same potential as the central taps of the transformers 42 and 43 and no potential can be introduced into either circuit from the other.

To simplify the explanation in connection with Figs. 4 and 5, only a portion of the leakage paths has been illustrated. Actually, in practice, in addition to the leakage paths shown in Fig. 4, there would be a leakage path from conductor 27 to conductor 30 and from conductor 28 to conductor 29. However, all these leakage paths are intercepted by the partition 7. Similarly in Fig. 5 there might be leakage paths from each side of the circuit 40 to both sides of circuit 41 but all such leakage paths would extend through a point of common potential represented by the partition 7.

Of course it will be understood that if the resistances of the leakage paths from each conductor of one circuit to both conductors of the other circuit were exactly the same, there would be no resultant cross talk and there would be no need for the present invention. However, in practice the different leakage paths are practically always of different resistances so that the resultant effect may be correctly represented by the diagrams of Figs. 4 and 5.

Heretofore the connectors disclosed in Figs. 1 and 2 have been described as consisting of four connecting members in four line conductors corresponding to the four line conductors shown in Figs. 4 and 5. When the system consists of two ungrounded metallic circuits, as shown in Fig. 4, the partitions 7 and 21 need not be grounded. However, when a grounded system as shown in Fig. 5 is employed, then the partitions 7 and 21 should be grounded and a ground wire 47 may be employed connected to a prong 48 which is mounted directly in the partition 7 and not insulated therefrom. Prong 48 may cooperate with a sleeve 49 in the female member 2, which sleeve 49 is mounted directly in and electrically connected to the partition 21.

Heretofore the only leakage paths discussed in connection with the structure shown in Figs. 1 and 2, are those which exist across the surfaces of the insulating bushings 13. These are the most important leakage paths because they are usually relatively short. However another surface leakage path can exist on the insulated wires and it is to prevent circuit coupling as a result of such leakage that the partition 14 is provided. Such a leakage path may be traced as follows between the wires connected to the prongs 11 and 12, respectively:

From the bare end of the wire 17 connected to prong 11, over the surface of the insulation 18 on that wire to a point 50 where the insulation of the wire referred to is in contact with the exterior surface of the insulation on the wire connected to prong 12, and thence back over the surface of the insulation on the latter wire to the wire itself, this path being indicated in Fig. 1 by the dotted line 51. However, since the insulated wires all pass through apertures in the metallic plate 14 and are in intimate contact therewith, the leakage paths are all short circuited by the partition 14 and the latter is preferably connected as by a wire 53 to the partition 7. Therefore all of the leakage paths, both those existing across the surfaces of the bushing 13 and those existing along the surfaces of the insulation 18 on the wires 17, are intercepted by a common conductor of negligible resistance.

As previously indicated, the present invention is applicable to other apparatus than telephone connectors of the type disclosed in Figs. 1 and 2. As one other example, a multiple knife switch is shown in Fig. 3. This switch comprises a plurality of movable blades 60 and associated contacts 61 adapted to be connected in different circuits. Each blade 60 and associated contact 61 are mounted upon a common base 62 of insulating material and the different bases 62 are interconnected by bolts 63 extending therethrough. However, the different bases 62 are separated by metal laminations 64 which intercept all leakage paths between the bases. These laminations 64 are preferably interconnected to each other and to the connecting bolts 63 by a conductor 65 of low resistance so that all are maintained at the same potential.

The operation of the switch shown in Fig. 3 to prevent intercoupling between different circuits incorporating different ones of the switch elements 60 and 61, will be readily understood from the previous detailed description with reference to Figs. 1, 4 and 5.

Although as previously indicated certain specific forms that the invention may assume have been described in detail for the purposes of explanation, the invention is in no sense limited to the exact form shown, but is to be limited only to the extent set forth in the appended claims.

I claim:

1. In electrical apparatus including a plurality of signaling circuits, conducting elements in the separate circuits bridged by solid insulating material that is subject to current leakage under some conditions, neutralizing conductive means interposed between said conducting elements and separated therefrom by said insulating material, said conductive means interrupting all leakage paths of said insulating material between said conducting elements, and means for maintaining said neutralizing conductive means at a neutral potential with respect to said circuits.

2. In electrical apparatus including a plurality of signaling circuits, conducting elements in the separate circuits bridged by solid insulating material that is subject to current leakage under some conditions, at least one of said signaling circuits including two of said conducting elements, and neutralizing conductive means interposed between the conducting elements in different circuits and separated therefrom by said insulating material, said neutralizing conductive means interrupting all leakage paths of said insulating material between the conducting elements of different signaling circuits.

3. In electrical apparatus including a pair of metallic signaling circuits, each circuit including two conductors, a conducting element in each conductor, said elements being separated from each other by solid insulating material that is subject to current leakage under some conditions, and neutralizing conductive means interposed between said conducting elements and separated therefrom by said insulating material, said neutralizing conductive means interrupting all leakage paths of said insulating material between the conducting elements in said two metallic circuits.

4. In electrical apparatus including a pair of independent signaling circuits having a common neutral connection, conductors for said separate circuits including conducting elements separated from each other by solid insulating material that is subject to current leakage under some conditions, and neutralizing conductive means interposed between said conducting elements, said conductive elements interrupting all leakage paths of said insulating material between the conducting elements in said independent signaling circuits, said neutralizing means being connected to said common neutral connection.

5. Connector means for completing conductors of a plurality of separate signaling circuits, comprising a pair of conductive contacting elements in each conductor of each circuit, solid insulating material for supporting said contacting elements in spaced relation to each other, said insulating material being subject to current leakage under some conditions, and neutralizing conductive means interposed between the conductive contacting elements of separate signaling circuits.

6. Connector means comprising a pair of frame members, one of said frame members having a plurality of conductive contacting elements and the other frame member having a plurality of cooperating contacting members, the contacting members on the two frame members being adapted to complete electrical connection in response to movement of said frame members together, in which each frame member comprises a plurality of insulating members each supporting one of said contacting elements, and supporting means of conductive material supporting said insulating elements and extending therebetween.

7. Electrical connector means for completing conductors in a plurality of independent circuits, comprising a plug member and a cooperating socket member, each of said members having a plurality of electrical contacting elements and insulated conductors leading from said respective conductor elements, in which each member includes a plate of conductive material having separate apertures through which said separate insulated conductors extend.

8. Electrical conductor means comprising a frame, a plurality of electrical conductor ele-

ments of conductive material, an insulating bush-
ing supporting each conductor element, a com-
mon conductive member supporting and being
in electrical contact with all of said insulating
5 bushings, a plurality of insulated conductors each
connected to one of said conductor elements, and
a conductive member supporting an insulated

portion of each conductor in spaced relation from
the other conductors, the portions of said in-
sulated conductors between said contactor ele-
ments and said plate being in spaced relation to
each other.

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