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PLUG AND SOCKET JOINT SUITABLE FOR ELECTRICAL
CONDUCTORS CARRYING HIGH-FREQUENCY CURRENTS
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Fig. 1.

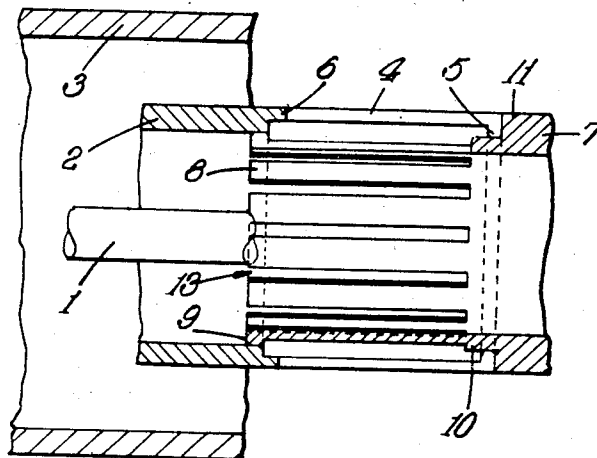
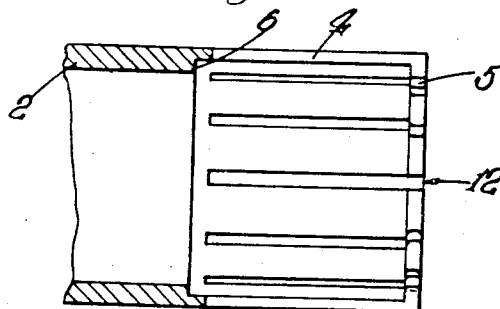


Fig. 2.



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PLUG AND SOCKET JOINT SUITABLE FOR
ELECTRICAL CONDUCTORS CARRYING
HIGH-FREQUENCY CURRENTSKenneth Eric Latimer and Stanley Carlos Smith,
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National Bank and Trust Company, Hartford,
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The present invention relates to plug and socket joints suitable for electrical conductors carrying high frequency currents and is particularly applicable to hollow conductors arranged to have current flow in the skins represented by both their inner and outer surfaces.

Thus in the communication art it is already known to use triple coaxial transmission lines which under certain circumstances may also be referred to as resonators, i. e. when they are fairly short and standing waves are set up within them. The advantages of such lines become increasingly apparent at high frequencies in which case two entirely independent circuits may be set up, namely between the centre conductor and the intermediate conductor, and between the intermediate conductor and the outer conductor, these two circuits having negligible coupling between each other, owing to the fact that the currents are confined to the skin of the conductors. Such circuits are also favourable in cases where a direct connection between a transmission line or resonator and valve is desired, for the circuits to the cathode, grid and plate may often be arranged conveniently in the form of a triple coaxial structure. At such high frequencies the surface of the conductors must be clean and if possible highly polished, in order to reduce the losses, for when considerable skin effect is present a layer of tarnish may form an appreciable proportion of the current-carrying skin. Silver is the ideal material for the skins of the conductors but it needs periodic cleaning to avoid tarnish due to silver sulphide, etc. The chief object of the invention is to facilitate the making of easily demountable assemblies of equipment such as triple coaxial transmission lines or resonators without introducing appreciable losses at the junction between two demountable parts of the same conductor.

In order to make a high conductivity joint between two demountable conductors, it is well-known that they must be pressed together firmly, preferably by some form of spring, and that they must be arranged to wipe together when the contact is made and broken so as to dislodge dirt. A plug and socket type of joint of known type is suitable when only low frequencies are involved or when high frequency currents are to be conducted on one side only of the conductor, e. g. on the inner side of the outer conductor, or the outer side of the inner conductor. Where currents flow in both skins of a conductor as occurs in the case of the intermediate conductor of a triple coaxial system, a difficulty arises in that the ordinary type of plug and socket connection does not provide for

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rubbing contact on both surfaces so that a path of a re-entrant nature is involved for one of the circuits. This difficulty is likely to be accentuated, owing to the flexible nature of the assembly since the impedance of the path would be apt to change considerably if shear stresses were applied to the plug and socket, so perhaps altering the tuning.

According to the invention an improved type of plug and socket joint is provided in which two separate groups of resilient contact members are arranged to complete independent contact paths over the inner and outer surfaces of a hollow conductor.

The invention is applicable with particular advantage for connecting consecutive sections of a metal shell whose inner and outer surfaces act as boundary surfaces forming guides for electromagnetic waves propagated in the spaces respectively inside and outside the shell; in this case one group of contact members carry currents flowing on the outside of the shell and the other group carry currents flowing on the inside of the shell, neither system of currents having to traverse the crevice formed by the metal contact members.

In the embodiment of the invention shown in the accompanying drawings, the contact members are utilised at a joint in the intermediate conductors of a triple coaxial system,

Fig. 1 being a longitudinal section through the complete assembly and Fig. 2 showing only the left hand member of the intermediate conductor of Fig. 1.

The triple coaxial system shown consists of a central rod 1, a coaxial cylindrical intermediate conductor 2 and an outer cylindrical conductor 3. Such a system may be used as a transmission line or as a resonator, and in both uses the intermediate conductor carries or guides currents at both inner and outer surfaces. The intermediate conductor 2 is shown as connected to a further cylindrical conductor 7 which may be a simple continuation of the conductor 2 or may constitute the means for connection to another component of a transmission or resonant system, e. g. one of the terminals of a valve.

To provide the electrical connections at the inner and outer surfaces of the intermediate conductor, two groups of spring fingers 4 and 8 are provided. The spring fingers 4 which are separated by gaps 12 are integral with the conductor 2 and their outer faces lie in a cylindrical surface contiguous with the outer surface of the conductor 2. In the radial direction the fingers are of

smaller dimension than the conductor 2 so that a shoulder 6 is formed. At their free ends, the fingers 4 are provided with inwardly directed projections 5 forming a divided internal collar. The spring fingers 8 which are separated by gaps 13 are integral with the conductor 7 and their inner faces lie on the continuation of the internal cylindrical surface of the conductor 7. At their free ends, the fingers 8 are provided with outwardly directed projections 9 forming a divided external collar adapted to engage the inner surface of the conductor 2. Between the main part of the conductor 7 and the fingers 8 is an annular portion forming a shoulder 10 which is engaged by the projections 5 on the fingers 4. A further shoulder 11 on the conductor 7 serves as an end stop for the fingers 4.

In this way, the outer surface of the fingers 4 carries the outer currents and the inner surface of the fingers 8 carries the inside currents, and neither system of currents has to traverse the crevice formed by the contact members. Moreover, the projections 5 and 9 at the ends of the fingers 4 and 8 ensure a wiping action during the making and breaking of the joint without introducing undue wear and without affecting the polish on the current-carrying surfaces.

The connections for the inner and outer conductors 1 and 3 of the triple co-axial conductor may be of conventional type and are not shown.

If the joint in the intermediate conductor 2 is required to resist some measure of mechanical tension the contact faces between shoulder 6 and projections 9 on the one hand and between shoulder 10 and projections 5 on the other hand may be furnished with co-operating protuberances and depressions so that the two parts will click together.

Instead of one set of fingers being disposed on one component and the other set on the other component, the two sets of spring fingers may both be provided on the same component, one set (corresponding to fingers 4) co-operating with the outer surface of the other component and the other set (corresponding to the fingers 8) co-operating with the inner surface of the other component.

It will be understood that the invention is not limited to cylindrical conductors and might in certain circumstances be advantageous for conductors with some other curvature or plane conductors.

We claim:

1. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which the intermediate and the outer conductors surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively travel along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug-and-socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other conductor, the second element extending into said first contact element and having an end portion in contact with the inner surface of the first element, said first contact element having its end portion in contact with the outer surface of said second contact element and the adjacent surfaces of said

elements between said contact end portions being spaced apart to provide two separate series electrical current paths along the inner and the outer surfaces of said connector elements.

2. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which the intermediate and the outer conductors surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively travel along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug-and-socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other conductor, the second element extending into said first contact element and having an end portion in contact with the inner surface of the first element, said first contact element having an inwardly projecting end portion in contact with the outer surface of said second contact element and the adjacent surfaces of said elements between said contact end portions being spaced apart to provide two separate series electrical current paths along the inner and the outer surfaces of said connector elements.

3. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which the intermediate and the outer conductors surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively travel along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug-and-socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other conductor and extending into said first contact element and having an end portion in contact with the inner surface of the first element, said first contact element consisting of a group of cylindrically disposed finger segments spaced apart and having radially inwardly projecting end portions in contact with the outer surface of said second contact element and the adjacent inner peripheral surfaces of said elements between said contact portions being spaced apart to provide two separate electrical current paths along the inner and outer surfaces of said connector elements.

4. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which the intermediate and the outer conductors surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively travel along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug-and-socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other

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conductor and extending into said first contact element and having an outwardly projecting end portion in contact with the inner surface of the first element, said first contact element having an inwardly projecting end portion in contact with the outer surface of said second contact element, said inwardly projecting end portions and said outwardly projecting end portions overlapping and being separated by an annular space between adjacently positioned surfaces of said elements to provide two separate electrical current paths along the inner and the outer surfaces respectively of said connector elements.

5. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which the intermediate and the outer conductors surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively travel along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug-and-socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other conductor and consisting of a group of finger segments cylindrically disposed and spaced apart the second element extending into said first contact element and having outwardly projecting end portions in contact with the inner surface of the first element, said first contact element also consisting of a group of finger segments cylindrically disposed and spaced apart and having inwardly projecting end portions, said inwardly projecting end portions of the first connector element and said outwardly projecting end portions of the second connector element forming an annular space between adjacently positioned surfaces of said elements to provide two separate electrical current paths along the inner and the outer surfaces of said connector elements.

6. A metal plug and socket connector for connecting intermediate tubular conductors of two three-conductor high frequency lines in which

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the intermediate and outer conductor surround the inner conductor, whereby the electric current of the field between the outer conductor and the intermediate conductor and the current of the field between the intermediate conductor and the inner conductor may each respectively traverse along a substantially continuous surface path without having to traverse a crevice formed by the metal elements of the plug and socket connector, said connector comprising a tubular contact element adapted to be connected to one of said conductors and a second contact element adapted to be connected to the other conductor, said second contact element comprising a group of finger segments having at one end thereof outwardly projecting portions to make contact with the inside surface of the first contact element, said second contact element also having a base portion to which said finger elements are secured in cylindrical spaced relation at the free ends thereof, said base portion having a smaller diameter than the outer surface of the second member and forming therewith an outwardly directed shoulder, said first contact element comprising a group of finger segments having at one end thereof inwardly projecting portions to engage and contact the said shoulder, and a base portion on said first contact element supporting said finger segments in spaced relation at the other ends thereof, said inwardly projecting end portions and said outwardly projecting end portions forming an annular space between adjacently positioned surfaces of said elements to provide two separate electrical current paths along the inner and the outer surfaces of said connector elements.

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