

May 9, 1967

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3,318,785

METHOD OF FORMING CONTACT ASSEMBLIES

Filed Oct. 23, 1963

3 Sheets-Sheet 1

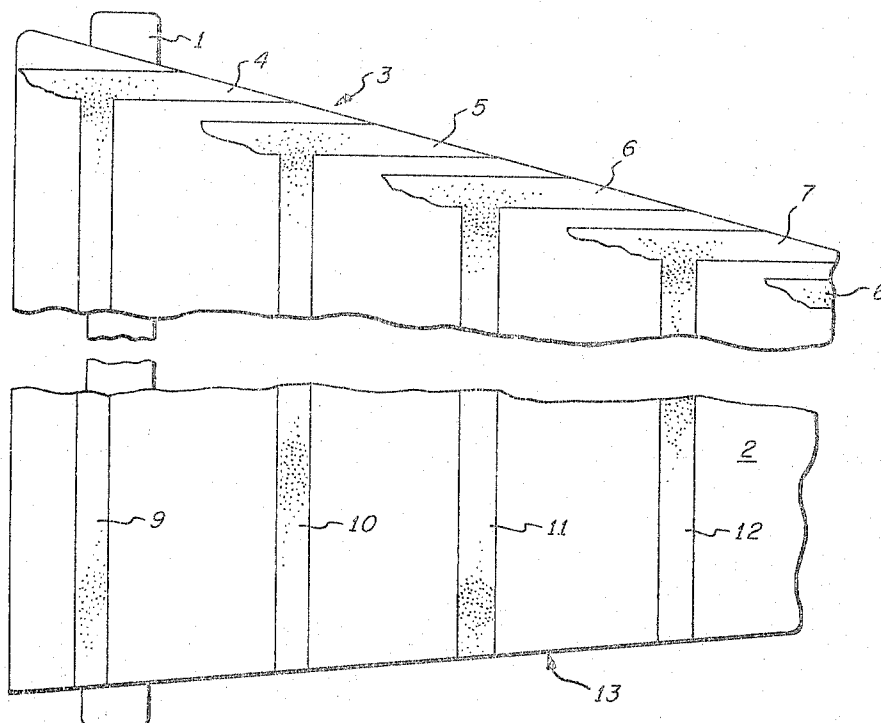


FIG. 1.

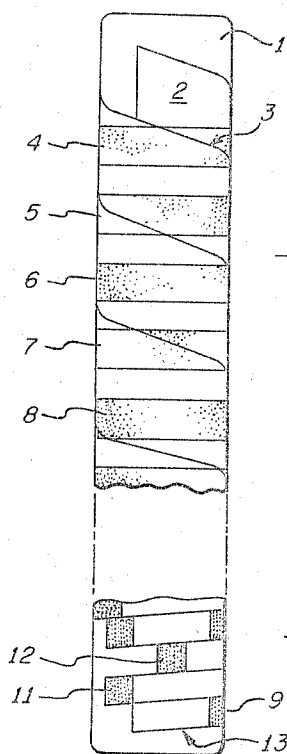


FIG. 2.

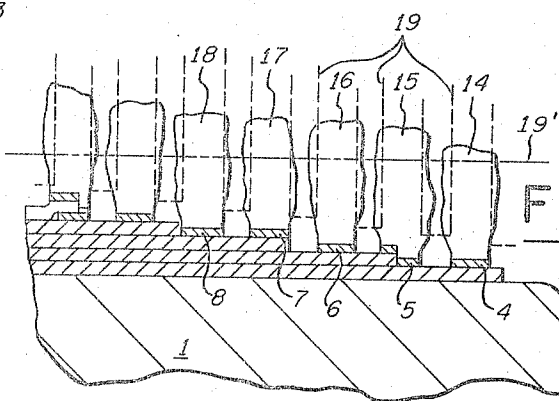


FIG. 3.

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FIG. 4.

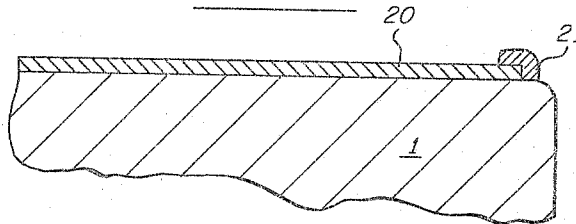


FIG. 5.

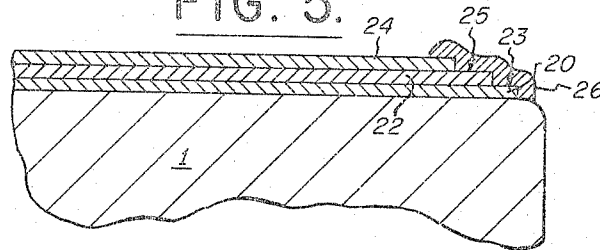


FIG. 6.

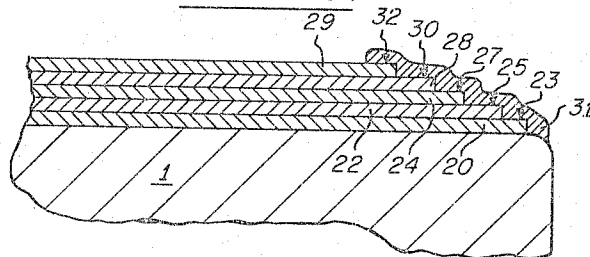
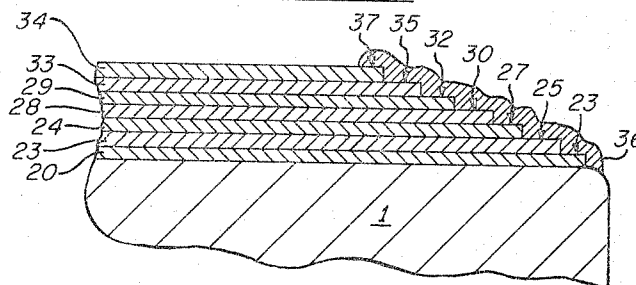


FIG. 7.



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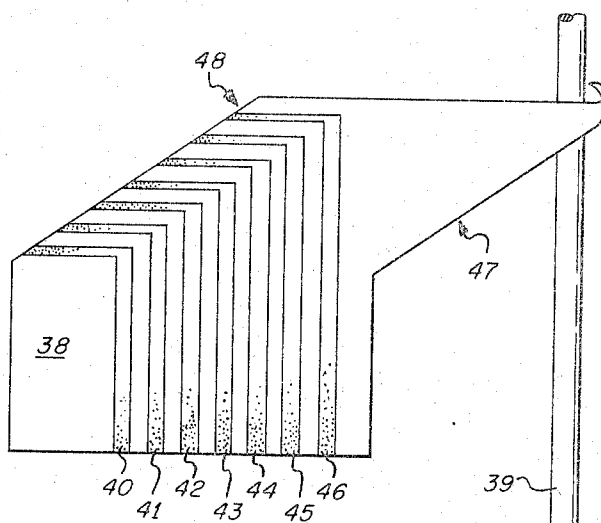


FIG. 8.

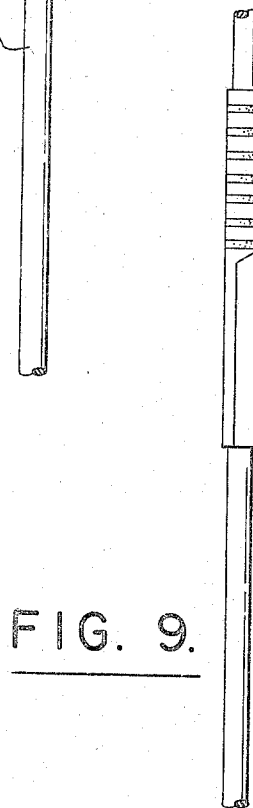


FIG. 9.

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METHOD OF FORMING CONTACT ASSEMBLIES

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Claims priority, application Great Britain, Oct. 23, 1962,
40,079/62

4 Claims. (Cl. 204—25)

The invention relates to a method of forming assemblies of contacts such as are required for use as slip-rings for instruments and servo-mechanisms, and also for certain types of plug and socket connections.

When it is required to make an electrical connection between a stationary and a revolving part of an apparatus, this may be done by means of slip rings, which consist of metal rings carried on an insulating body, a connection being made to the metal of the slip ring and also to a brush which bears against a surface of the slip ring. Either the slip rings or the brushes may be mounted on the revolving body. Usually a number of electrical connections will be required, so that the slip rings will be mounted together in assemblies which consist of from two rings upwards, in some cases to 50 or more.

It is an object of the present invention to provide a method of making an assembly of contacts which is suitable, among other purposes, for making slip ring assemblies.

According to the present invention a method of forming an assembly of ring-shaped contacts comprises forming on a core successive layers stepped back at at least one set of their edges, the layers being of insulating material bearing conductive regions defining the bases of contact rings on the steps, and forming a conducting path providing an electrical connection to each separate contact ring base, and depositing metal on the contact ring bases to form the contact rings.

In one method of carrying out the invention the conducting regions may be first formed on an insulating film which is then wound round the core so that an edge lies spirally, each turn, except the innermost, exposing a portion of the turn below to form a step. The pattern of conducting regions is such that the exposed steps carry the contact ring bases; an insulated conducting path providing a connection to each contact ring base extends under the overlying layers.

In a second method according to the invention a succession of insulating layers are formed, one over another, on the core, each having conducting regions formed on it, and each layer being limited in extent to expose a portion of the previous layer and form a step carrying a contact ring base.

In either of the above methods the formation of the layers with steps carrying the contact ring bases is followed by depositing metal on the bases to form the contact rings. In the case of small contact rings such as are used for slip rings this may conveniently be done by electroplating. The metal so deposited may then be trued up by machining, the assembly encapsulated in a suitable plastic material, and the cylindrical outer surface then machined to provide a smooth surface exposing the contact faces of the rings.

Generally the assembly will require to be accurately cylindrical, in which case the core should be cylindrical. However, in some cases the assembly may be required to depart from strict circularity in cross-section; for example, a contact assembly forming part of the plug of a plug-and-socket connector may require to be of D-shaped cross-section so that the plug may be inserted into a socket having a locking-plate with an aperture of corresponding

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section and be locked into position by rotating it. Such an assembly may be built up on a core of D-shaped section.

An essential step in carrying out the present invention lies in forming the conducting regions of an insulated surface and it is essential that this be carried out in such a way as to provide a continuous adherent coating of good quality. A method suitable for this purpose is described in our U.S. application S.N. 273,565, filed Apr. 7, 1963, now abandoned.

The invention will be further described by way of example with reference to the accompanying drawings, in which:

FIGS. 1 to 3 represent diagrammatically various stages in the forming of a slip-ring assembly according to the first method described above.

FIGS. 4 to 7 represent diagrammatically the formation of a slip-ring assembly according to the second method described above, and

FIGS. 8 and 9 represent diagrammatically the formation of a slip-ring assembly according to a modification of the method of FIGS. 1 to 3. The thicknesses of the layers are greatly exaggerated in the figures for clarity of explanation.

Referring first to FIG. 1, a slip-ring assembly is to be formed on a cylindrical core 1, which may be of stainless steel, by winding about it an insulating film 2 carrying conductive regions to form slip-ring bases and conducting paths. The film 2 is of very thin polyethylene terephthalate foil, for example, 0.0005" thickness, and is slightly tapering in width along its length, so that, when the sheet is wound round the core, one edge, 3, follows a spiral path, each layer exposing a step of the layer below it.

On the film 2, near to the edge 3, are a succession of conducting strips 4, 5, 6, 7, and 8, slightly inclined to the edge 3 and formed by the method described in the above abandoned application.

From each of the strips 4, 5, 6, 7, there extends a conducting path forming a connecting strip 9, 10, 11, 12, respectively, perpendicular to the length of the film 2, and extending down to the opposite edge of the film 13. This edge is also cut on a slant so that it will leave spiral steps exposing short portions at the ends of the strips 9 to 12 to enable the connections to be made to them.

The strip 2 is wound round the core 1 so that the edges lie in spirals, forming successive steps, as is shown in FIG. 2. If desired, an adhesive may be used to secure the strip; however, this is not essential since the turns will be secured subsequently by the formation of the rings.

Referring now to this figure, the strips 4, 5, 6, 7 and 8 now extend fully round the circumference of the wrapped core and each of them is connected to a connecting strip extending between the layers of plastic film and exposed at the lower edge 13, which also lies in a spiral, but of much closer pitch. The strips 4 to 8 thus form rings which function as the slip ring bases.

Preferably the spacing between the strips 9, 10, 11, 12 is not an exact fraction of the circumference of the core, so that they lie spaced round the core when the film is wound in place. The spacing must be sufficient for adequate insulation and is greatly exaggerated in the figure.

The end of the film is secured by adhesive and a wire is wrapped round the end of the assembly to make contact with the ends of the connecting strips 9, 10, 11, 12 etc., and the assembly is then placed in an electro-plating bath to build up metal rings on the bases 4, 5, 6, 7, 8.

The metal rings built up in this way appear in FIG. 3 respectively as 14, 15, 16, 17, 18 and as the assembly comes from the plating bath they are, of course, somewhat irregular in diameter, and cross-section. The assembly is then cleaned, mounted in a lathe, and the faces

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of the slip rings facing in the direction of the axis of the core 1 are trued up by means of a narrow cutting tool shaped like a parting-off tool as shown by the dotted outlines 19, care being taken not to feed the tool in fully to the roots of the slip rings so as to avoid any risk of tearing the plastic film or damaging the connecting strips.

The assembly is then cleaned and dried and vacuum encapsulated in a suitable plastic, for example an epoxy resin, the resin being polymerised in place. The encapsulated assembly is then returned to the lathe and trued up along the dotted line 19' so as to leave exposed the contact surfaces only of the slip rings 14, 15, 16, 17, 18, etc., the main parts of the rings being embedded in insulating plastic. Soldered connections may be made to the slip rings from the ends of the strips 9, 10, 11, 12 (shown in FIG. 2) and if required these ends may be reinforced by electroplating also.

The second method of forming a slip-ring assembly according to the invention will now be described with reference to FIGS. 4 to 7. In this method a core 1 which, as before, may be of stainless steel is coated with a thin layer of a plastic insulating composition 20 which is then polymerised in position. The polymerised layer 20 is not affected by ordinary solvents. A wide range of plastic compositions are suitable, including those based on melamine or epoxy, vinyl, or phenolic resin.

The surface of the layer 20 is treated with a catalyst solution as described in our above mentioned application as a preliminary to the deposition on it of a metal layer, and dried. A ring 21 of a masking composition readily soluble in a suitable solvent, for example, an acetone-based cellulose paint, is applied to cover the edge of the layer 20. FIG. 4 shows a fragmentary longitudinal section of the treated core at this stage.

A metal layer 22 (shown in FIG. 5) is then deposited from a metallizing solution on the part of the catalysed surface of the insulating layer 20 which is not masked by the ring 21. The ring 21 of masking material is then dissolved away leaving an insulating ring 23, and the partly-fabricated assembly cleaned and dried.

A layer 24 of plastic material, similar in composition to the layer 20, is then applied over the metal layer 22, but stopping short of the edge of the layer 22 to leave a metallised ring 25. This layer 24 is then polymerised to render it hard and insoluble in normal solvents.

The assembly is then again treated with a metallizing catalyst as before, and dried.

A further ring of masking composition, 26, is then applied to the end of the assembly so as to cover the ring 23 at the end of the first insulating layer 20, the metallized ring 25 and a further narrow ring 27 of the insulating layer 24, the disposition of the layers being now as shown in FIG. 5. The assembly is then placed in a bath of metallizing solution to build up a layer 28 of metal (shown in FIG. 6). The ring of masking material 26 is then cleaned off with solvent.

A further layer 29 of the same plastic insulating material as the layers 20 and 24 is then applied over the metal layer 27 but stopping short of its edge so as to leave a ring of metal 30. This is polymerised and treated with a metallizing catalyst as before. After drying a further masking ring 31 is applied covering the edges of the previous layers and a ring 32 of the layer 29, and a fresh metal layer 33 is built up.

This succession of steps is repeated as often as necessary, FIG. 7 showing the position at a later stage in the process. The core bears a succession of insulating layers 20, 24, 29, 34 carrying metal layers 22, 28 and 33 on their surfaces, and stepped back one above the other exposing rings 25, 30, 35, which form the bases for the slip rings, separated by insulating rings 23, 27, 32. At the other end of the core a similar series of rings may be formed by the other ends of the metallized layers to provide terminals to which soldered connections may be made. Al-

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ternatively, by suitable masking before each metallizing step, the layers of metal 22, 28, 33, etc., may be limited to form the rings 25, 30, 35, and strips, corresponding to the connecting strips 9, 10, 11, 12 of the method described with reference to FIG. 1.

The ring bases constituted by the metal rings 25, 30 and 35 are next built up to form the slip rings by depositing metal on them, for example, by metal spraying or electroplating, and the slip rings are finished as described above with reference to FIG. 3.

The method of forming a slip ring assembly illustrated in FIGS. 8 and 9 is a modification of that described with respect to FIGS. 1 to 3.

In this method insulating film 38 carrying conductive regions is wound about a core 39. The film 38 carries a number of conducting strips of which seven are shown in the figure referenced 40 to 46 inclusive. Each is in the form of an inverted letter L, one limb of which forms the slip-ring base while the other forms a conducting strip to enable connection to be made to the slip ring.

The film 38 is in the form of a strip having two parallel sides, and having part of its leading edge 47, cut at an angle of 45°, and part of its trailing edge, 48, parallel to the edge 47. The portions of the conducting strips 40 to 46 which will form the slip-ring bases are arranged along this part, 48, parallel to the length of the strip, while the other limbs of the L, which form the connecting strips reach across the width of the strip where they are soldered to wires (not shown in the figures).

The strips 40 to 44 may be prepared by a metallizing process as previously described, or may be cut out of foil, for example, thin gold leaf, and secured in position on the film 38 with an adhesive.

The insulating film, 38, is now wound round the core 39, starting with the apex formed by the edge 47, so that the strips 40 to 46 form complete rings where they overlap at the edge 48, these rings forming the slip-ring bases, and leaving the connecting lines (not shown) projecting from the lower edge of the film.

Since the edges 47 and 48 are parallel to one another, the thickness of insulating material underlying these rings is constant, and the assembly does not taper as does that of FIGURES 1 to 3.

The formation of the slip ring assembly is completed as previously described by building up metal on the slip ring bases, followed by finishing as described with reference to FIG. 3.

Only seven slip-ring bases are shown in the embodiment of FIGS. 8 and 9, but a far greater number can be accommodated if desired.

We claim:

1. A method of forming an assembly of ring-shaped contacts comprising forming on a cylindrical core successive overlapping layers stepped back at at least one end thereof, the layers being of insulating material and bearing conductive regions defining the bases of contact rings on the steps and forming a conducting path providing an electrical connection to each separate contact ring base, and depositing metal on the contact ring bases to form the contact rings.

2. A method according to claim 1 in which the conducting regions are formed on an insulating film which is then wound round the core so that an edge lies spirally, each turn except the innermost exposing a portion of the turn below to form a step, and the pattern of conducting regions being such that the exposed steps carry the contact ring bases and an insulated conducting path providing a connection to each contact ring base extends under the overlying layers.

3. A method according to claim 1 in which a succession of insulating layers are formed, one over another, on

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the core, each having conducting regions formed on it, and each layer being limited in extent to expose a portion of the previous layer so as to form a step carrying a contact ring base.

4. A method according to claim 1 in which the deposition of metal to form the contact rings is carried out by electro-plating.

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