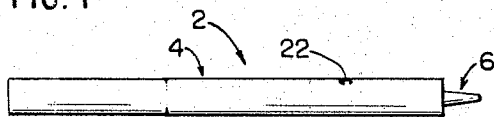
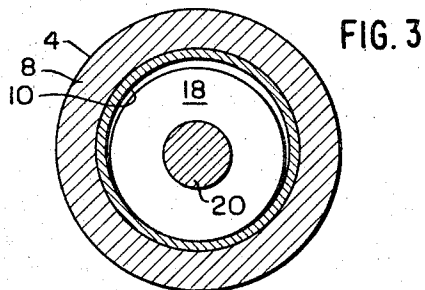
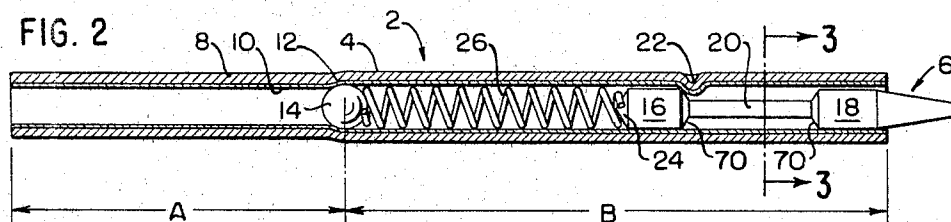
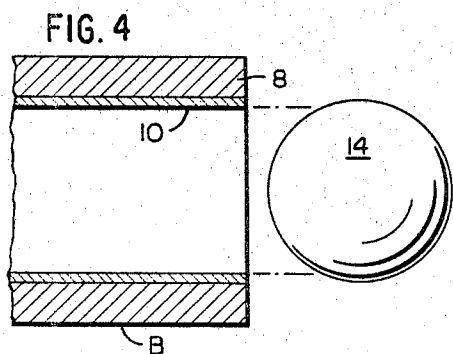
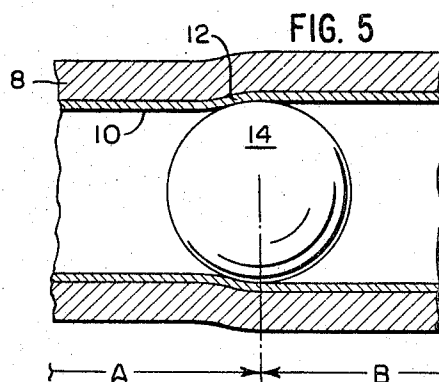
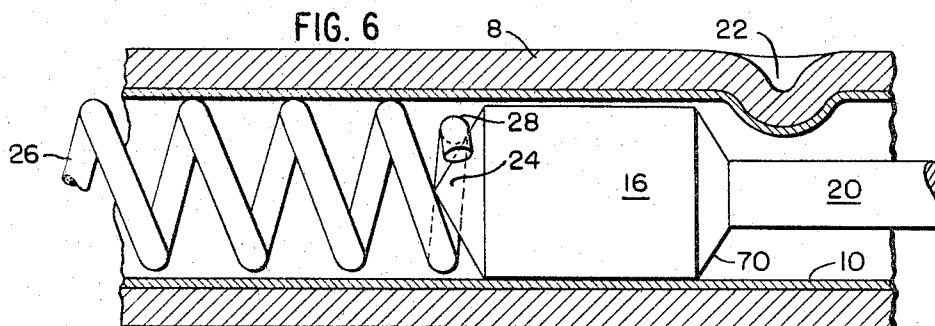


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ELECTRICAL CONTACT

Filed March 28, 1968

Sheet 1 of 2



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3,435,168

Filed March 28, 1968

Sheet 2 of 2

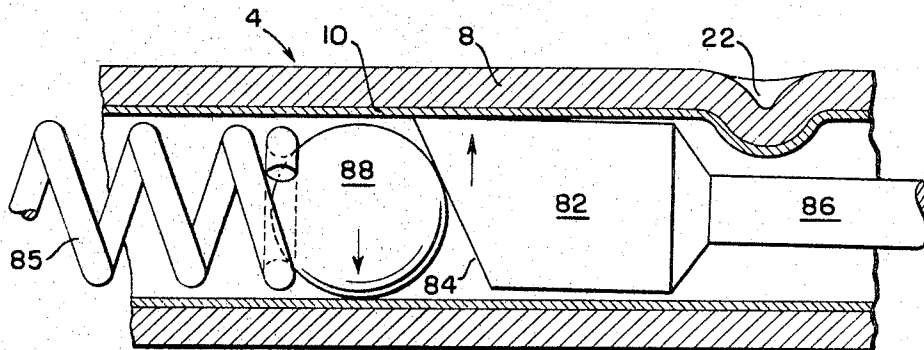


FIG. 7

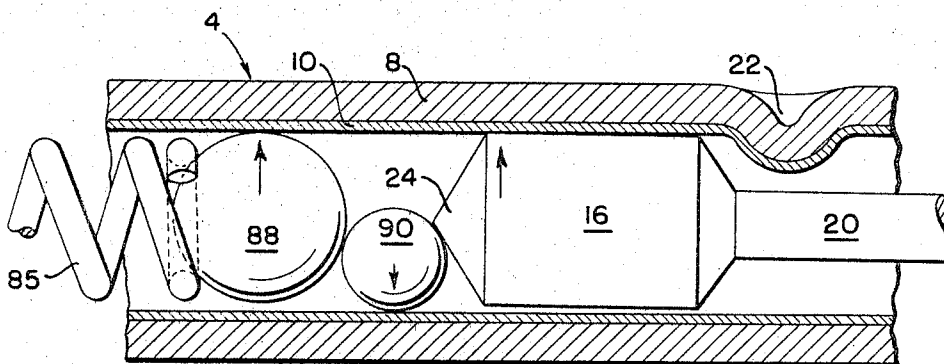


FIG. 8

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3,435,168

ELECTRICAL CONTACT

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Continuation-in-part of application Ser. No. 617,945, Feb. 23, 1967. This application Mar. 28, 1968, Ser. No. 721,551

Int. Cl. H01h 1/36

U.S. Cl. 200—166

14 Claims

ABSTRACT OF THE DISCLOSURE

This invention is a plunger-type electrical contact of improved design. The contact consists of a metallic tube which may be either single layered or plural layered, within which slides a plunger, the end of the plunger extending outwardly from the tube to act as a contact. Within the tube is a smoothly polished ball which has been forcibly pushed into the tubing so as to expand slightly and burnish a portion of the inside wall thereof, within which the plunger slides. Suitable means retain the plunger in the tube, and a compression spring in the tube biases the plunger outwardly.

This application is a continuation-in-part of U.S. patent application Ser. No. 617,945, filed Feb. 23, 1967, now abandoned.

Background of invention

As indicated in the abstract, the field of the invention is electrical contacts of the plunger type, that is, an electrical contact in the form of a tube or other body having a tubular bore. In this bore is mounted and retained in slidable fashion a plunger. A compression spring is mounted inside the bore which biases the plunger outwardly. In use, the contact is mounted in some kind of a holding body, and is pressed axially against a mating contact. The resilience of the spring provides a resilient contact pressure. Generally, electrical connections to the contact are made either in the form of plugs inserted in the other end of the contact, or lead wires are soldered into the other end of the bore.

While little difficulty has been experienced in the tubular type contacts that are rather large in size and therefore might be called coarse contacts, nevertheless in today's modern usage of extremely complicated electrical or electronic apparatus to which several hundred electrical connections may need be made and then possibly changed from time to time, the prior art contacts have in general been found to be unsatisfactory. When it is realized that in a typical operation, a total contact assembly comprising several hundred of such plunger-type contacts may be used, each contact being very small in size, and that the extending plunger of each one of these contacts must make a positive, unfailing electrical engagement with another circuit, some idea of the problems involved can begin to be understood. When it is also realized that the probability of failure of an electrical system varies exponentially with the number of elements that can fail, and in a system where one has a contact plate or contact assembly in which several hundred contacts are used, the probability of failure becomes enormously large. Again, this greatly increases the need for precision and unfailing performance in such miniaturized contacts.

The failure of performance of such contacts can rise from many causes. One is that the plunger may gall against the inner wall of the tube which holds it, and then "hang-up" within the tube, thus making no contact

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at all. Another is that corrosive atmospheres may get into the tube and corrode the inner surfaces of the wall of the tube as well as the outer surfaces of the plunger, thus leading to poor, or intermittent (and in some cases complete failure of) electrical contact between the plunger portion of the contact and its wall. Furthermore, if soldered connections are made to the other end of the tube, it is often customary for these soldered connections to be made by inserting the lead wire down the bore of the tube and using molten solder and flux to make the solder connection. In so doing, it has been found that the solder and solder flux tend to flow along the bore of the tube because of capillary action (particularly if the contact tube itself is rather small), thus rendering inoperative the entire contact.

Thus, a high percentage of rejects in the manufacture of the miniaturized contacts of the type of this invention is experienced, with resulting high cost. If the reject is not picked up initially, then when a contact plate assembly of several hundred contacts are put together and used, one or more of these contacts may be found to be defective with the result that the whole plate must be thrown away. Needless to say this can be very expensive and dangerous.

Summary of invention

Therefore, in such contacts, the need in today's complex electrical equipment is for a plunger type contact which is unfailing in its performance, and may be made cheaply and economically in any size desired. There is need for such a contact in which solder connections may be made at the other end without any possibility of solder or fluxes moving by capillary action along the rest of the contact with resulting change or failure of the contact. There is need for a contact in which the electrical characteristics of the contact remain constant, with the result that the voltage drop across the contact remains constant. Finally, there is need for a contact which has a smooth action and is so constructed that there will be an extremely high probability that the contact will operate satisfactorily in use over a long period of time. It is the object of this invention to provide a contact having all of the above characteristics.

Broadly speaking, therefore, the invention provides a tubular type contact having an extending plunger which is a smooth sliding fit inside the tube itself. By tube is meant either a tube itself, or a body of metal provided with a bore into which such a plunger may fit. The basic principles of the invention apply to such a single body in which there are one or more bores into which the plungers of this invention fit, or to a single tubular member having a single plunger projecting therefrom. The inner wall of the contact member (be it a metal body having a bore therein or a metal tube) is burnished smooth by placing at its end a smoothly polished ball, preferably of steel or stainless steel, and then forcibly pushing the ball part way along the length of the bore or tube. As the ball is so inserted, it burnishes and sizes the inside wall of the tube or bore. The ball is left in place, and because of its tight fit inside the bore of the contact, it serves as an effective seal or plug to prevent any solder or flux from flowing by it and into those portions of the tube in which the plunger and its compression spring are placed. A feature of the invention lies in the use of a tubular body which is lined with a precious metal lining.

The invention accordingly comprises the elements and combinations of elements, arrangements of parts, features of construction, and steps and sequence of steps, and features of operation of the methods, all of which will be exemplified in the structures of the article and in the methods hereinafter described, and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawings, in which are shown several embodiments of the invention:

FIG. 1 is an enlarged, general illustration of a first embodiment of this invention;

FIG. 2 is a cross-section of the FIG. 1 embodiment, showing the general arrangement of the operative parts therein;

FIG. 3 is an enlarged cross-sectional elevation of the FIG. 1 embodiment, taken in the direction of sight lines 3—3 on FIG. 2;

FIG. 4 is a greatly enlarged, sectional elevation of one end of the contact tube of the FIG. 1 embodiment, showing in exaggerated form a ball (or plug) which is to be forcibly shoved into the tube;

FIG. 5 shows a portion, also greatly enlarged, of the FIGS. 2 and 4 construction after the ball of FIG. 4 has been forcibly fitted into the contact tube;

FIG. 6 is a sectional view, also greatly enlarged, of a portion of the embodiment, showing the relationship between the end of a spring used in this invention and the plunger thereof.

FIG. 7 is a sectional elevation of a second embodiment of the invention; and

FIG. 8 is a sectional elevation of a third embodiment of the invention.

Throughout the several drawings, similar reference characters indicate corresponding parts. In several of the drawings, the parts have been greatly exaggerated, and their relative dimensions have also been exaggerated, in order to aid in understanding the invention.

Referring first to FIG. 1, there is shown, and indicated generally by numeral 2, one embodiment of the contact of this invention. The contact generally comprises a tubular member 4 from which projects the end 6 of a plunger.

Referring now to FIG. 2, there is shown in greater detail the interior construction of the contact 2. The wall 4 is preferably made of at least two layers, the outer layer 8 being a base metal such as brass, nickel, steel, or stainless steel, and the inner layer 10 being a precious metal such as is customarily used in electrical contact work. The metal 10 may be selected from the group of material comprising gold or gold alloys, silver or silver alloys, or platinum and the platinum family metals and alloys. The function of the inner layer 10 is to provide the maximum possible surety of good electrical contact being made between the plunger 6 and the body 4. Lining 10 is preferably brazed to the outer shell 8, or may be solid-phase bonded thereto.

It will be noted that the tubular body 4 comprises a first end section A and a second end or portion B. The reason for thus designating these two sections is that their inner diameters are different, and these sections meet at a junction point 12 at which junction point there is positioned a plug 14. In this embodiment, the plug 14 is shown as a round spherical ball, but it may be made of other shapes such as a short section of a cylinder. It is preferred that a round ball be used, and preferably a ball made for a ball bearing. The ball may be of steel, nickel, nickel alloys, or even brass. It is preferred to have the ball of material harder than the lining 10. Such ball bearings are made with dimensional tolerances of plus or minus a few millionths of an inch, and by the use of such a ball in this invention, the same kind of dimensional tolerance of the inner diameter of portion B of the body 4 will be attained, as will now be described.

A ball 14 is provided which is slightly larger than the inner diameter of portion B. Typical size relationship will be given below in the discussion of actual contacts that have been used. FIG. 4 illustrates, in exaggerated fashion, this disparity in the relative diameter of the ball 14 and the inner diameter of the end portion B prior to insertion of the ball. The difference in diameters is illustrated more fully in FIG. 5 in exaggerated fashion, the diameter of portion A being the original inner diameter of the tube, and the diameter of portion B being substantially the diameter of ball 14.

In the manufacture of the contact, after the tube 4 is cut to the desired length, then a ball 14 is centered at the end of portion B and is forcibly pushed into the tubing to the position indicated by numeral 12. In so doing, the ball 14 expands the portion B of the tubing, and burnishes the inside surface of the wall of this portion of the contact. At the same time that it so burnishes it, the use of balls made for ball-bearings will insure almost absolute uniformity of the inner diameters of portion B from contact to contact, provided the material of body 4 is the same, and the history of manufacture of the material of body 4 is the same from lot to lot, so that the material has the same hardness or spring-back characteristics.

It is realized, of course, that when one cold-works a metal, there will be a certain amount of spring-back of the metal. The amount of spring-back will be determined, among other things, by the prior history of the manufacture of the particular material being used. In the instant case, if the prior history of the material from which the tube 4 is made, and the manufacturing operation is such as to make the tube 4 the same, then the very slight spring-back of the material of portion B of the contact will be almost the same from contact to contact. Since, as explained above, the tolerances of the ball 14 are in the order of a few millionths of an inch, then it can be said that the diameter tolerances of the inner diameter of portion B of the tube 4 will be within a few millionths of an inch from contact to contact. The plunger 6 is so made that the dimensional tolerances of the diameters of the portions 16 and 18 are closely controlled, and thus since the tolerances of the inner diameter of portion B of the contact are also closely controlled, there can be a very precise but very smooth sliding fit between the plunger 6 and portion B of the contact.

It is also to be noted that because the ball 14 is force fitted into the tubing 4, the ball 14 is under compression at the junction 12. Because it is under compression, if the end portion A of the contact is used to make solder connections, this compression fit of the ball 14 at the junctions 12 effectively prevents the passage of any fluxes or solders past the ball and into the operative portion B of the contact. This is one of the features of the invention.

The plunger 6 is preferably dumbbell shaped with the two end portions 16 and 18 and the connecting link or shank 20. Due to the dumbbell shape, a clearance space is provided between the smaller diameter of the shank 20 and the inner diameter of the tube. The plunger 6 is retained within the cylinder and adapted for longitudinal sliding therein by a retaining means which extends from the wall of portion B into the space between the shank 20 and the wall of the tube. In this embodiment, this inward extension is formed by dimpling the wall at one or more points to provide the inwardly projecting dimples 22. Thus, the distance that the plunger 6 can slide along the tube is defined by the length of the dumbbell link or shank 20.

Between the ball 14 and the inner end 24 of the dumbbell is positioned a compression spring 26. One of the purposes of the compression spring is to bias the plunger 6 in an outward direction. The other purpose is now described.

Even though the fit of the plunger 6 in the portion B of the contact is a smooth sliding fit, nevertheless it may be desired to further enhance the certainty of the plunger making electrical contact with the inner wall of portion B and thus with the entire contact 2. To this end, it will be noted that the inner end 24 of plunger section 16 is cone-shaped. The end turn 28 of the spring 26 is so formed as to lie across the end of the spring in such position that it is off-center of the spring axis, and thus off-center of the apex of cone 24. As a result, this inner end engages the cone between the apex thereof and its base on section 16. As a result, there will be a lateral component of spring force which will tend to bias the end section 16 against the inner wall of portion B. Thus the spring serves to bias the plunger outwardly, and to provide a component of force biasing the plunger against the inner wall of the tube,

It will be noted that in several views of the drawing, in order to clarify this sidewise thrust, the clearance between the plunger and the inner wall of the tube has been shown in exaggerated manner. In actual practice, this clearance is probably not over a fraction of a thousandth of an inch, due to the accuracy of manufacture of the components, and possibly the above-mentioned spring-back.

It has been specified above that preferably the lining 10 is preferably brazed to shell 8 or is solid phase bonded thereto. The method of making the particular material is not part of this invention, and is well known in the art. It is sufficient to say the tubing 4 may be made by first making the tubing in a large size so that the materials are relatively easy to handle, the lining 10 being secured in place during the initial stages of manufacture. Then the tubing with its liner in place is drawn down either in wire drawing machines or board drawing machines, to the requisite size for these contacts. If the lining 10 is brazed in or put in by a solid phase bonding technique, of which several are known, then the lining 10 will be securely fastened to the outer shell 8. If, on the contrary, a mechanical fit is utilized to hold liner 10 in shell 8, it is to be noted that by the forcing of the ball 14 into the tubing, and thus the expansion of the portion B, the lining 10 is brought into close, intimate contact with the outer shell, and because the ball 14 is retained in the tubing, there is no chance of the lining 10 coming loose from the shell 8 during the use of the contact.

If desired, for contacts where extreme accuracy or certainty of performance of these contacts is not desired, or the contact is to operate in an inert or non-corroding atmosphere, the lining 10 may be omitted, and the entire body of the tube 4 may be made of a base material such as Phosphor bronze or brass. If expense is no object, the entire tube 4 may be made of precious contact metal, such as, for example, a gold alloy, or silver, or platinum.

Similarly, if desired, the lining 10 may be placed within the bore of the tube 4 by means of an electroplating operation. However, it is a general experience that it is very difficult to electroplate uniformly within the bores of contact tubes of such small diameters as these contacts have. The result is that the contacts do not have the certainty of performance required, and thus the preferred material is that either in which the lining 10 is used, and the tubing 4 is made in such manner that there is a brazed or solid-phase bond between the lining 10 and 8; or a tubing entirely of precious metal is used. However, if gold electroplating is used, then it is to be noted that by the forcing of ball 14 down the portion B, the gold plating is burnished and rendered non-porous, thus leading to better operation of the contact even when a gold electroplated inner surface is used.

It is also to be noted that the spring 26 may be gold plated or silver plated, and also the plunger 6 may be gold plated.

In connection with the use of the indentations or dimples 22 to retain the plunger 6 within the bore of the tube 4, it will be noted that for convenience of manufacture the dimple is not made having sharp inner corners. The result is that if the edges of the shoulders of sections 16 and 18 are left right-angled, such sharp corners may tend to dig into the wall of the dimples, and thus the plunger may "hang-up." For this reason, it is preferred that the inner edges 70 of the sections 16 and 18 be provided with a bevel to eliminate this chance of hang-up of the plunger against the dimples 22. A bevel such as 30° has been found satisfactory.

As an example of the use of contacts of this invention, a typical contact which is being made is one of which several hundred are mounted in a single plastic contact-holding block. These tubular type contacts are so mounted that the plungers 6 all extend outwardly on the same side of the block, and then in use the assembly is pressed against a punch card such as a program controller card. Where the card is punched, the plungers of the contacts pass

through the card and make contact with suitably positioned and oriented contacts on the base plate against which the card is mounted. A typical contact for this purpose has the following characteristics:

	Contact A
5 Length of contact -----inches--	0.280±0.003
Outside diameter of contact ----do----	0.030±0.0005
Inside diameter of portion A ----do----	0.022±0.0005
Diameter of ball 14 -----do-----	0.023±0.00005
10 Diameter of plunger 6 (gold-plated) -----inches--	0.0205±0.0005
Length of plunger 6 -----do-----	0.115±0.002
Length of section 16 (not including cone) -----inches--	0.025±0.002
15 Length of section 18 -----do-----	0.045±0.002
Spring 26 (material) -----Beryllium copper gold-plated	
Wire diameter -----inches--	0.004±0.0005
Free length -----do-----	0.130±0.010
Turns (active) -----	10
20 Turn diameter (O.D.) -----inches--	0.020±0.001
Thickness of layer 10 -----do-----	0.0003
Material of layer 10 (gold) -----	18K
Material of body 4 -----	Brass

Referring now to FIG. 7, a second embodiment of the invention is shown, the figure being a portion of the embodiment, the rest of the embodiment being the same as in the FIGS. 1-6 embodiment.

In this embodiment, the tubing 4 is provided which has the wall 8 and the inner layer 10, the latter being provided (as in the first embodiment) to insure the maximum possible surety of good electrical contact between the electrical plunger contact and the body 4. A plunger contact is provided as in the first embodiment but in which the inner end portion 82 is cut on a bias as shown at numeral 84. The complete plunger has a shank 86 similar to the shank 20 of the FIG. 1 embodiment, and the outer end of this plunger is shaped as the plunger of the FIG. 1 embodiment is shaped. That is, the plunger of this embodiment is like the plunger of the FIG. 1 embodiment in all respects, except for the end 84 which is cut on a slant of approximately 25° to the axis of the tube.

A spring 85 is provided as in the FIG. 1 embodiment, the inner end of the spring resting against a ball 14 (not shown in this drawing) which is mounted in this embodiment the same as in the FIG. 1 embodiment. The other end of the spring is ended as is customary in springs, that is, with a full turn, and between this end of the spring and the slanted end 84 of the plunger is positioned a ball 88 which is a sliding fit in the tube 4.

The result of this construction is that when the spring 85 presses against the ball 88 to move it against the end 82 of the plunger, there is a component of force perpendicular to the axis of the tube which will urge the end 82 of the plunger against the inner wall of the tube, thus insuring a positive electrical contact at all times.

Referring now to FIG. 8, a third embodiment of the invention is shown in which, as in the first two embodiments, a tube 4 is provided having the outer portion 8 and the inner layer 10 for the purpose as set forth above. A plunger is provided in this case which is like the plunger of the FIGS. 1-6 embodiment, that is, it comprises the plunger end 16, and the shank 20, with an outer end (not shown) similar to the outer end 18 of the FIG. 1 plunger. A spring 85 is provided as in the FIG. 7 embodiment, this spring resting against a ball 14 (not shown in this drawing) at one end, and the other end of the spring terminating in a full turn as in the FIG. 7 embodiment. A ball 88 similar to ball 88 of FIG. 7 is provided to make engagement with the end of spring 85 as shown, but between ball 88 and the conical end 24 of the plunger is placed a second ball 90 which is smaller in diameter than the ball 88. The diameter of the ball 90 is preferably two-thirds the diameter of the ball 88, but other

diameters can be used. The important thing is that the ball 90 is small enough so that it bears against a face of the conical end 24 as shown, and not on the point of the plunger end 16.

Again, as in the FIG. 7 embodiment, because of the off-center relationship of the bearing points of the balls 88 and 90 and the conical end 24 of the plunger of this embodiment, a component of force is engendered which will thrust the plunger end 16 securely but slidably against the inner wall of the tube, thus insuring a positive electrical contact at all times.

In view of the fact that the conical end of the plunger portion 16 may be made (along with the plunger itself) an automatic screw machine, the construction shown in FIG. 8 will be found very economical to make, since the balls 88 and 90 may be purchased at low cost due to their mass production.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, nor to the methods described, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein are for the purpose of description and not of limitation.

As many changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

Having described the invention, what is claimed is:

1. A plunger-type electrical contact comprising:

- a metal body having a bore therein, the bore having a first end-portion and a second end-portion, the portions having a junction zone between the ends of the bore, and the inner diameter of the first end-portion being less than the inner diameter of the second end-portion;
- a metal plug tightly fitting in the body and positioned at said junction, the diameter of the plug being greater than the inner diameter of said first end-portion and substantially the same as the inner diameter of said second end-portion;
- a contact plunger slidably fitting in said second end-portion;
- a compression spring in said second end-portion between said plug and the inner end of the plunger to bias the plunger outwardly; and
- retaining means extending inwardly of the wall of said second end-portion for retaining the plunger slidably in the second end-portion.

2. The electrical contact of claim 1 in which said metal body is a tube having a wall comprising a plurality of layers bonded together, the innermost layer forming the inner wall of the tube and being made of a precious metal.

3. The electrical contact of claim 2 in which said innermost layer is gold or gold alloys.

4. The electrical contact of claim 1 in which said plug is a spherical ball having a smooth surface.

5. The electrical contact of claim 1 in which the inner wall of said second end-portion is smoothly burnished.

6. The electrical contact of claim 1 in which said contact plunger comprises a dumbbell-shaped member, the outer diameters of the ends of the dumbbell being a smooth sliding fit in said second inner portion.

7. The electrical contact of claim 1 in which said retaining means comprises an inwardly directed projection extending from the inner wall of the said second end-portion, said projection engaging a portion of said plunger which is of less diameter than the inner diameter of said second end-portion, whereby said plunger may slide along said second end-portion a distance defined by the length of said portion of the plunger.

8. The electrical contact of claim 1 in which the end of said second end-portion has the same inner diameter as the remaining length of said second end-portion, said plunger sliding smoothly through said end.

9. The contact of claim 1 in which the inner end of said plunger is shaped as a cone, and the end turn of said compression spring which meets said inner end of the plunger is formed off center of the axis of said spring, so that the spring biases said plunger radially against the inner wall of said tube.

10. The electrical contact of claim 1 in which the face of said inner end of the plunger is formed at an angle to the axis of said bore, the contact including means positioned between said face and said compression spring, said means being slidable in said bore and being forced by said spring against said face, thereby to create a component of force thrusting the inner end of the plunger against the wall of said bore.

11. The contact of claim 10 in which said means is a ball.

12. The contact of claim 10 in which said means is a pair of balls, one of the balls being adjacent the spring and of such a diameter as to be a smooth sliding fit in said bore, and the other ball being smaller than said one ball and lying between the latter and said face, whereby said other ball is off-center of the axis of said bore.

13. The method of making a plunger-type electrical contact comprising providing a metal tube which is to comprise the body of the contact;

providing a metal ball having a diameter greater than the inner diameter of said inner tube;

centering said ball over one end of said tube and forcing said ball into said tube for a portion of its length thereby to expand the tube while at the same time burnishing the inner wall of said portion;

inserting a compression spring in the tube within said expanded portion;

inserting a portion of the length of a plunger in said tube to compress said spring; and

inwardly deforming a portion of the wall of said tube in order to retain said plunger slidably therewithin.

14. The method of claim 13 in which said plunger is dumbbell-shaped having ends approximately the same diameter as that of said burnished portion, the ends being joined by a shank, and said deformation in the wall of the tube extends into the space between the inner wall of said expanded section and said shank, whereby said plunger can slide in said tube a distance determined by the length of said shank.

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U.S. Cl. X.R.

200—46; 29—630; 235—61.11; 174—75